AVIATION

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THE HYDRAULIC HAND PUMP WITH THE SEVEN-YEAR ADVANTAGE

THE NEW BENDIX PACIFIC

3000 PSI HAND PUMP

Latest development in the famous Pacific Division line of hydraulic hand pumps is the new 3/4 cubic inch capacity pump for 3000 PSI systems. In performance, reliability and in its easy-service advantages the new pump reflects this company's seven years of pioneering experience in aircraft hand pump design.

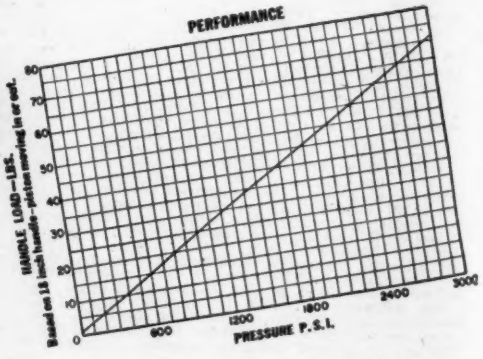
The pump incorporates a double-acting piston which produces equal volumes on the in and out strokes. An integral suction check valve employing the proven Bendix plastic poppet* is mounted at right angles to the main bore.

Weighing only 1.85 pounds, the new pump has been fully tested in accordance with Specification AN-P-14 (revised to 3000 PSI) and has met impact load requirements of twice the operating load on each stroke. Dependability and long life have been conclusively proven by the successful completion of a 250,000 cycle life test.

Maintenance has been simplified as all packings, nuts and bolts are AN Standard parts. The pump is available with or without handle. Complete data is available to engineering personnel of recognized manufacturers.

*U. S. Pat. No. 2358950

Pacific Division
Bendix Aviation Corporation
NORTH HOLLYWOOD 1, CALIF.



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BRIEFING

The explosion caused by the first use of the atomic bomb is still literally being felt 'round the world—and shock waves of various types will continue for a long time. For, although it is still too early to fully evaluate the potentialities of this miraculous achievement, we know atomic power is here to stay. If man is to live at all, he's going to live with that power.

To give all possible information—sound information, that is—we have brought into play full McGraw-Hill resources to give you a basic, over-all story. The result is a job of which we're extremely proud, not just because it includes work of men who were, shall we say, "very closely associated" with A-bomb development, but because we feel sure it will help you clarify what has been a most-confused situation. This 8-page illustrated article begins on page 103.

We've gone further than that though. Associate Editor Herb Powell has done a whale of a job (page 106) of interpreting the atomic bomb as it relates directly to the aircraft industry, pointing out some of the things that may happen.

Both articles are correlated by Editor Neville, who succinctly analyzes on page 105 the new discovery's implications with relation to the nation's research and development program.

Almost coincident with the war's end, the security lid has been lifted on another super hush-hush aid—radar. H. C. Lawrence, of Radio Corp. of America, has prepared an extremely interesting and valuable article on radar. And he does more than give the technical data on its operation—for he also discusses its peacetime uses, setting forth just how this war-developed equipment may well be applied to rapidly increase aircraft utility. See page 108.

Quality control throughout the war was vital to insure that the fighting men would have only the best. But the war's end doesn't mean that this control can be thrown out; in fact, it's still as important as ever, and competiton will keep it so. E. B. Sarreals, Industrial Analyst for the Kollsman Instrument Div. of Square D Co., shows in his article beginning on 138 how that company met and solved the problem.

As the personal plane makers begin to market their first postwar products, an old problem comes back to the fore—what to do about discounts on parts and accessories? Managing Editor Foster has contacted the nation's leading manufacturers to get the dope on their plans, hopes, and aspirations. The results, summarizing who'll get how much in the way of discounts, are presented on page 178.

Aircraft distributors and dealers will spot sales potentialities in our Civil Operations section story of how one man created a good floatplane business literally from scratch (page 180).

And there's data on eight new craft this month—four military, one airliner, two personal, and one helicopter. On page 167 are more of "Pete" Bulban's sketches of Jap planes; on 168 and 169 are first design details of Convair's mighty B-32 superbomber; on 170 are given all the releasable data on Lockheed's incomparable P-80 Shooting Star; on 171 a projected 30-passenger commercial liner by Convair; on 172 and 173 complete engineering data on a West Coast roadable helicopter approaching flight test stages; on 174 a four-place roadable "Air-Car"; and on 175 specifications for a two-place lightplane aimed at the $2,000-level.

This stands for honorable service to our country. To you, the lapel button shown above may be instantly recognizable as the Honorable Service Emblem awarded to veterans of the war just concluded; but to millions of people in the country it still means nothing. Every one of us can help in the tough reconversion days that lie ahead by knowing this badge—and remembering the sacrifices made by those who wear it.

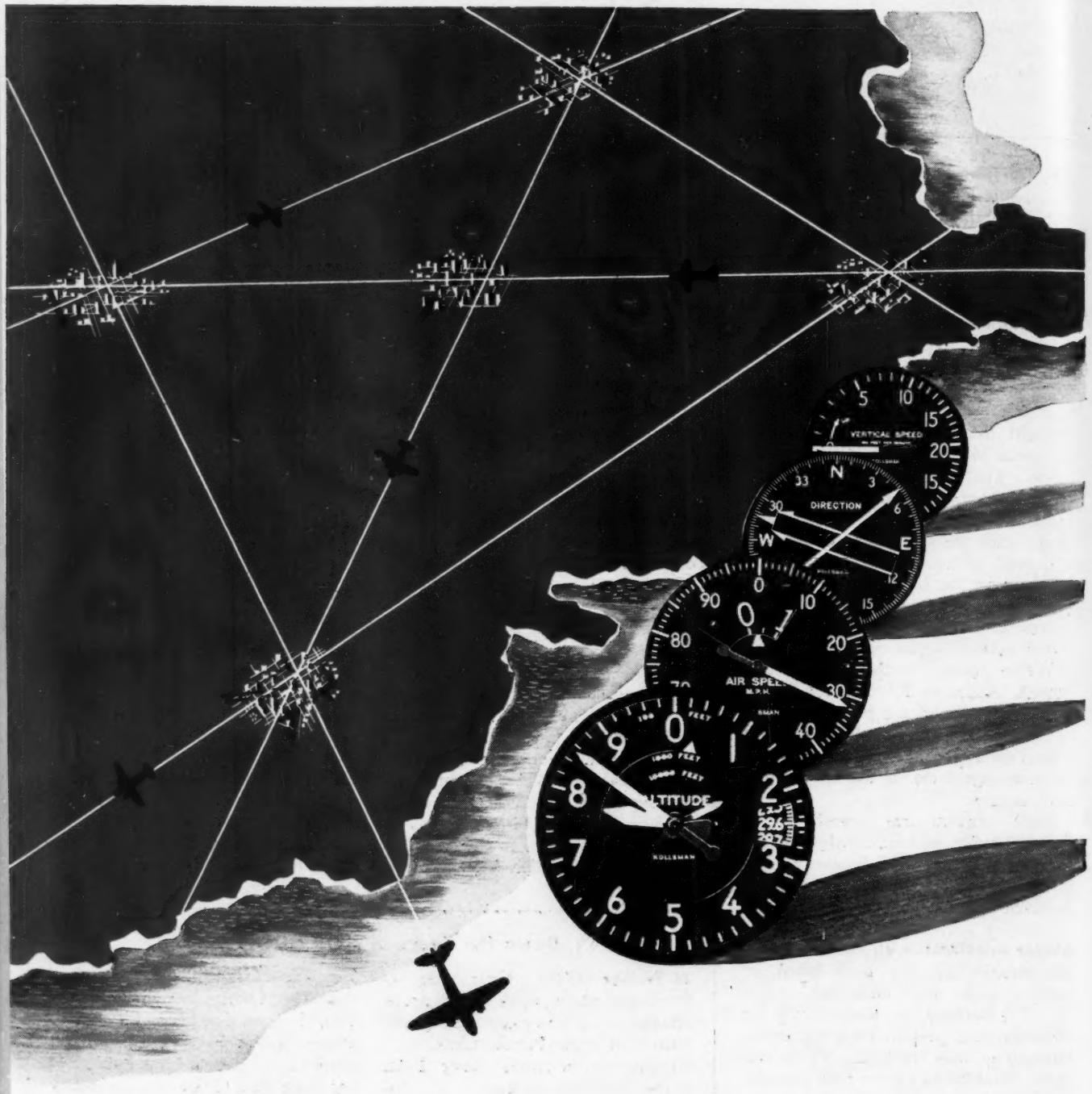
And last —but by no means least important—there are two other toppers: Part IV of Ralph Upson's outstanding series, this month probing the aeronautical "problem child," the pusher plane (page 128); and the conclusion of Irv Stone's searching Design Analysis of the Fairchild C-82 Packet (page 115).

Down the Years in AVIATION'S LOG

25 Yr. Ago (1920)—Four Army de-Havilland planes make first flight to Alaska. . . . Navy considers possibilities of trans-Pacific flight. . . . Aeromarine converts Navy F-5L flying boat into airliner. . . . International Balloon Race held at Chicago has eleven entries, eight foreign.

15 Yr. Ago (1930) — Aeronautical Chamber reports July aircraft sales down to 218, including Air Corps ships. . . . All five, Lockheed entrants in Los Angeles-Chicago nonstop race complete flight. . . . Frenchmen Costes and Bellonte complete Paris-New York flight in 37 hr. 18 min. with Hisso-powered Breguet. . . . National Air Tour of 35 planes leaves Detroit to visit 30 cities.

10 Yr. Ago (1935)— Boeing builds Model 299 bomber, prototype of B-17. . . . Navy orders 135 carrier scout-observation planes from Curtiss. . . . Chance Vought builds 84 SBU-1 scout-bombers for Navy. Planes mount Twin Wasp Jr. engines. . . . Italian Cant Z-501 flying boat flies 3,080 mi., non-stop from Italy to central Africa. . . . Bellanca incorporates parachutes into cabin-plane seats . . . . President signs Air Mail Act, also Wilcox Bill giving Army new air bases. . . . C & S reports that lowered fares bring 98% increase in passengers. . . . Airline passenger mileage is up to 139,400,000 for first 6 mo. of year, compared to 75,300,000 mi. in same period previous year. . . . Newark wins over New York in P. O. decision on air terminal . . . Air Corps program calls for 118 bombers, with total expenditure of $23,825,000 for year. . . . Navy enters balloon in International Race at Warsaw, Poland. . . . Consolidated opens San Diego plant.



PATTERN FOR TOMORROW'S AIRLINES. Along with good planes and pilots, the new regional and local airlines starting in business will need the best and most complete instrument equipment they can buy. Instruments are the backbone of safe operation . . . the kind of operation our pioneer airlines have taught the nation to expect in scheduled air transportation. Instruments also have everything to do with regularity of service, and this regularity of service—around the clock, around the calendar—means not only service to the public but the fullest and most economical use of the new air carrier's investment in equipment. Tomorrow's airlines will find Kollsman accuracy and dependability important aids to the safety, regularity and economy of their operations.

KOLLSMAN AIRCRAFT INSTRUMENTS

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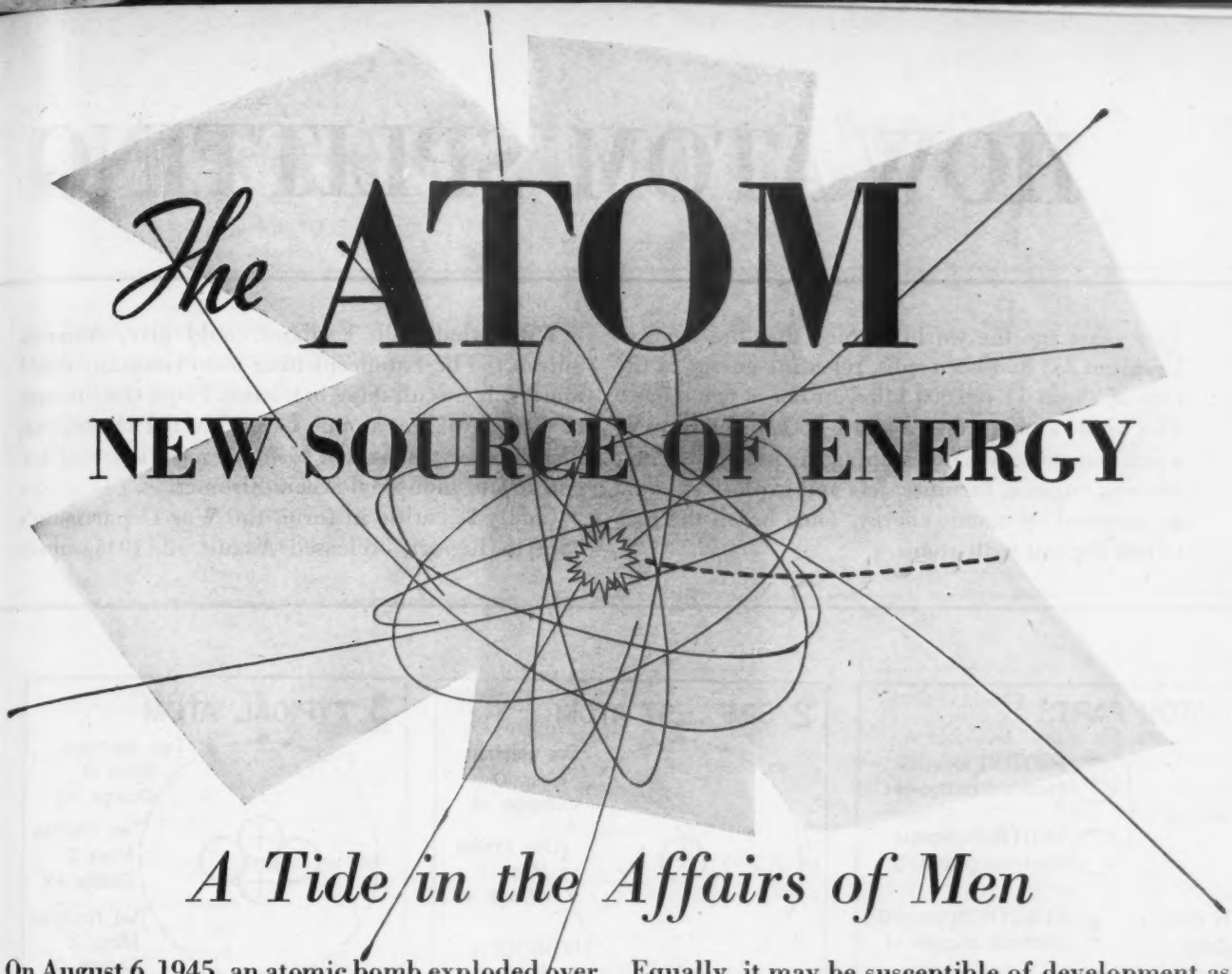

The ATOM
NEW SOURCE OF ENERGY

A Tide in the Affairs of Men

On August 6, 1945, an atomic bomb exploded over the Japanese city, Hiroshima.

Its concussion blasted the city, vaporized the fibre of Japan's will to resist, and flashed across the world a light of such glaring intensity that even blind eyes could glimpse the forked road that is presented to humanity's choice and destiny.

It has been a scant fifty years since Pierre and Marie Curie embarked upon their research with the avowed intent of discovering "how the atoms of the universe are put together". Their work contributed radium to the knowledge and use of mankind, but it marked only a way station upon the awesome quest which they announced and which thousands of scientists have since pursued.

Under the compelling stimulus of war, the first major application of the release of atomic force has been in an instrument that raises by an unimaginable dimension our ability to dole out death. We can be devoutly grateful that the scientific leadership of the Allies, and particularly the industrial strength of the United States, brought to us, rather than to our enemies, priority in the development of this dread weapon. But even in its present infant phase, it is clear that ownership of the principle of the atomic bomb carries a trusteeship of terrifying gravity.

We hold in trust a power that is capable of unraveling the very fabric of our civilization. Equally, it may be susceptible of development as a mighty force for human welfare. But we have proved the destructive use, while the constructive applications are still in the realm of speculation.

Clearly the trust is of a magnitude that transcends national jurisdiction. No walls have ever been built high enough to fence in the spread of scientific knowledge, and even if we were resolved to forego the harnessing of atomic power for peace, it is hopeless to think that its application for war can be held for long as the monopoly of one, or a small group of nations.

At one giant stride our scientific and technological development has so far outdistanced our social engineering, that we have no choice but to turn our full powers of creative imagination to control the forces we have unleashed and to bend them to man's use rather than to his destruction.

Since control is not possible without understanding, I have asked several of my editorial colleagues in the McGraw-Hill organization to present on the pages which follow a non-technical but authoritative account of the known facts and implications of atomic power.

James H. McGraw, Jr.

President, McGraw-Hill Publishing Co., Inc.

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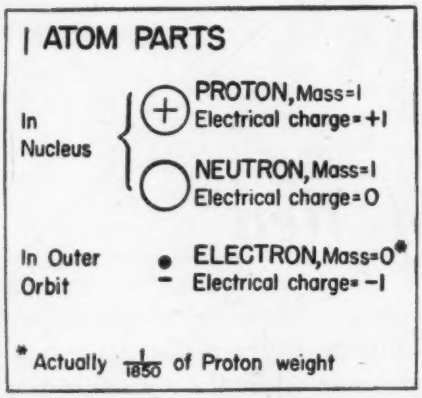
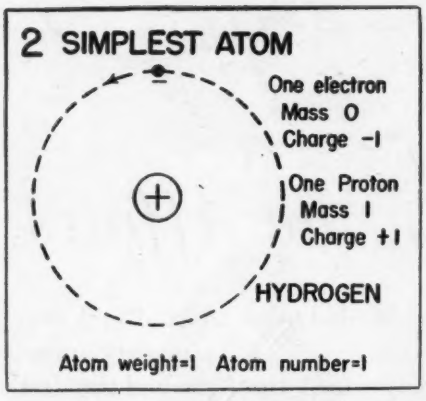
HOW ATOM SPLITTING

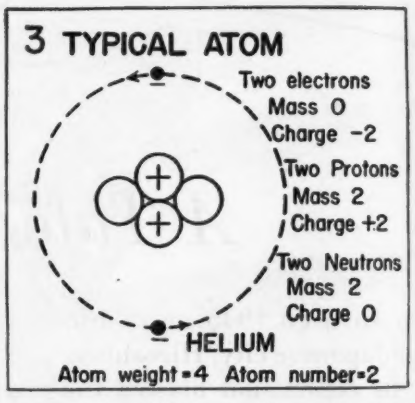
Five years ago the world learned that the atom of Uranium 235 had been split, releasing energy at the rate of about 11,400,000 kilowatt-hours per pound. The whole amount tested was less than the head of a pin, but there was no escaping the possibility that heaters, engines, turbines, jets and explosives could be powered by atomic energy. Then began the race to win the war with atoms.

With what help England could give, America outran the best atom-splitting team Germany could muster. It was all done in silence. From the summer of 1940 until the atomic bomb blasted Hiroshima, black secrecy blanketed history's most amazing scientific and industrial accomplishment.

Coldly scientific in form, the War Department's "Smyth Report," released August 12, 1945, traces

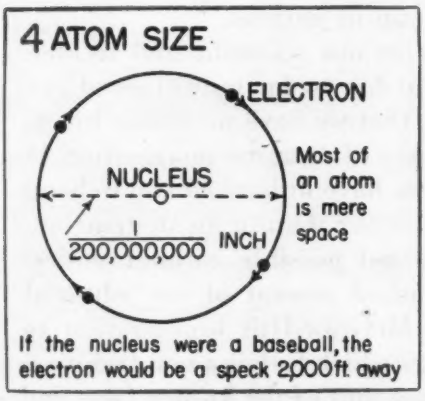


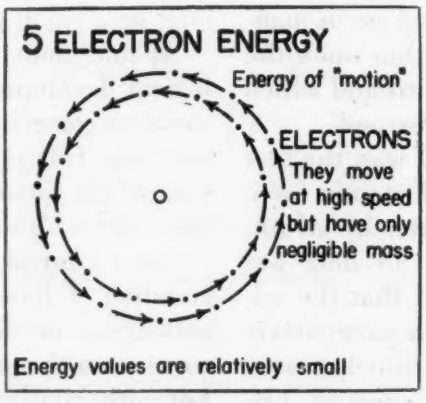


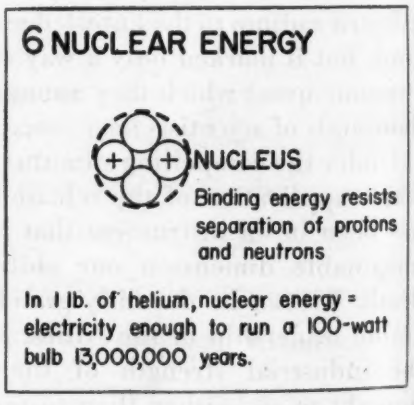


Each of the 92 elements has its own *atom*, yet all atoms are made from the same three pieces, Fig. 1: *proton* (weight 1, electric charge +1), *neutron* (weight 1, charge 0), *electron* (weight 0, charge −1).

Every atom is a tiny "solar system." Its central "sun" has one or more protons, generally neutrons too. The revolving "planets" are electrons, one for each proton in nucleus, because plus and minus must balance in the atom. The opposite charges attract, but high speed keeps the electrons out in their circular orbits, just as the centrifugal tendency of the revolving earth defies the sun's gravitational pull. All the weight of an atom is in the nucleus, so add the number of protons and neutrons to get the atom's weight. The *atomic number* is equal to the number of protons. The elements are known by their atomic numbers. Thus uranium (92 protons) is element 92.


4 ATOM SIZE
ELECTRON
NUCLEUS
Most of an atom is mere space
1/200,000,000 INCH
If the nucleus were a baseball, the electron would be a speck 2,000 ft away


5 ELECTRON ENERGY
Energy of "motion"
ELECTRONS
They move at high speed but have only negligible mass
Energy values are relatively small


6 NUCLEAR ENERGY
NUCLEUS
Binding energy resists separation of protons and neutrons
In 1 lb. of helium, nuclear energy = electricity enough to run a 100-watt bulb 13,000,000 years.

With only their outermost orbits touching, it would take half a million atoms to span the thickness of a human hair. Yet if one could expand an atom until its outer orbits encircled 100 acres, the nucleus would be no bigger than a baseball. The atom is mostly empty space, Fig. 4, and nuclei are difficult targets; so much so that a neutron bullet fired at a mass of atoms may pass right through without a hit.

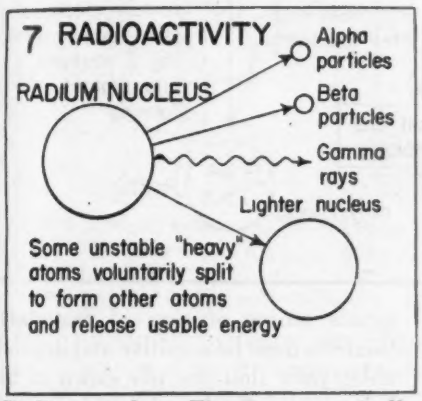
The almost weightless speeding electrons, Fig. 5, supply all the energy of chemical reactions (as when coal burns or TNT explodes). Evading all ordinary chemical action, the immensely greater energy bound up in the nucleus, Fig. 6, can be released only by direct hits on the nucleus to break the bonds that hold the protons and neutrons in a tight bundle.

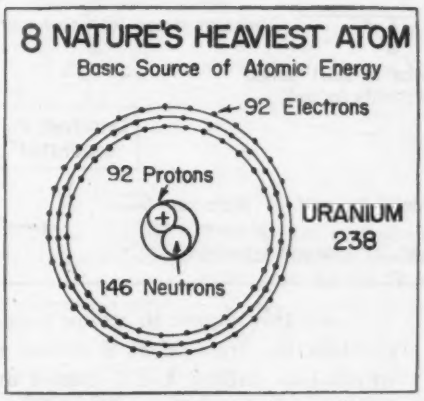
RELEASES ENERGY

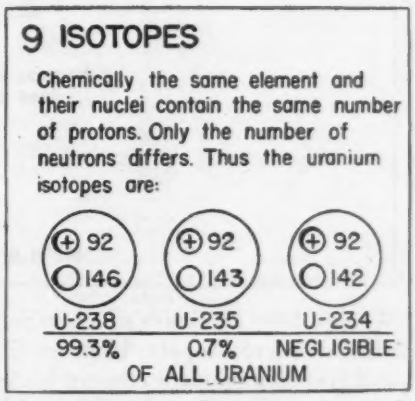
the fantastic course of atomic engineering through the five years of news blackout. It leaves no doubt that only a complete mobilization of America's technical resources could have won this victory in time.

Other writers in other places will unfold the epic story. This presentation leaves no space to reflect the glory of the accomplishment or even to record its history. The aim is more immediately practical — to give the professional and business readers of the McGraw-Hill publications a sound and honest, though non-technical, understanding of this atom-smashing business, so that they will know better what to do about it in their personal and business lives.

Now for step one: learning the shape of atoms and how atom splitting releases energy.

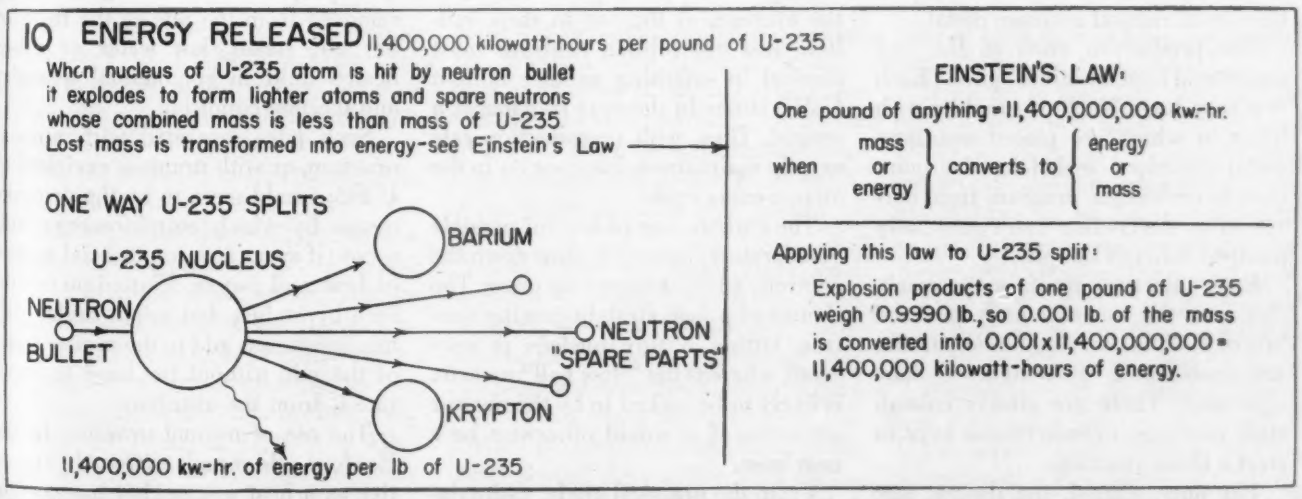






Radium nucleus, Fig. 7, automatically emits particles and energy as it decays to form nuclei of a lighter atom. Most common form of uranium, nature's heaviest atom, is Uranium 238, Fig. 8. This form is not directly useful for energy release, but is important as the raw material for a new synthetic power atom, *plutonium*.

An element may have several *isotopes* — alternate forms with the same number of protons but slightly different numbers of neutrons. Uranium 238 is the isotope in which protons and neutrons total 238 (so atom weight is 238). It is 99.3% of the total weight of pure, natural uranium. The stuff needed for direct atomic-energy release is Uranium 235, only 0.7% of the total weight and very difficult to separate from 238. To put it another way, every pound of energy-giving U-235 comes mixed with a dead load of 140 pounds of relatively inert U-238.


10 ENERGY RELEASED 11,400,000 kilowatt-hours per pound of U-235
When nucleus of U-235 atom is hit by neutron bullet it explodes to form lighter atoms and spare neutrons whose combined mass is less than mass of U-235 Lost mass is transformed into energy-see Einstein's Law
ONE WAY U-235 SPLITS
U-235 NUCLEUS
BARIUM
NEUTRON BULLET
NEUTRON "SPARE PARTS"
KRYPTON
11,400,000 kw.-hr. of energy per lb of U-235
EINSTEIN'S LAW:
One pound of anything = 11,400,000,000 kw.-hr.
when mass or energy converts to energy or mass
Applying this law to U-235 split:
Explosion products of one pound of U-235 weigh 0.9990 lb., so 0.001 lb. of the mass is converted into 0.001 x 11,400,000,000 = 11,400,000 kilowatt-hours of energy.

Slow neutron bullet splits Uranium 235 nuclear target, generating two lighter atoms (Fig. 10 shows one possibility) and several free neutrons ready to split other U-235 atoms. The following pages show how the original neutron may be produced and directed and how a chain of self-propagating atomic explosions may sweep through a block of U-235 like a forest fire to release heat energy equivalent to 11,400,000 kilowatt-hours per pound.

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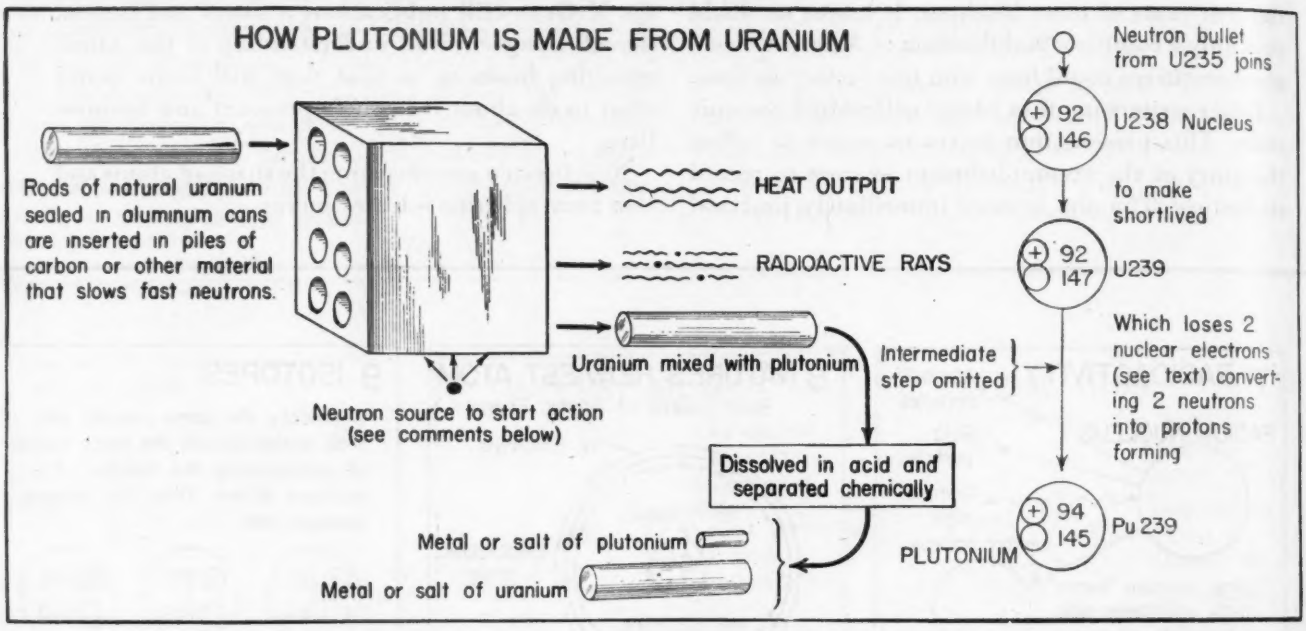
CREATING and ISOLATING

Man-Made Plutonium—U-235 Substitute


HOW PLUTONIUM IS MADE FROM URANIUM
Neutron bullet from U235 joins
92 146 U238 Nucleus
to make shortlived
92 147 U239
Which loses 2 nuclear electrons (see text) converting 2 neutrons into protons forming
94 145 Pu 239
PLUTONIUM
Rods of natural uranium sealed in aluminum cans are inserted in piles of carbon or other material that slows fast neutrons.
HEAT OUTPUT
RADIOACTIVE RAYS
Uranium mixed with plutonium
Intermediate step omitted
Neutron source to start action (see comments below)
Dissolved in acid and separated chemically
Metal or salt of plutonium
Metal or salt of uranium

We now have two kinds of atoms suitable for energy supply, Uranium 235 and the new man-made element No. 94, plutonium. Uranium, No. 92, has the heaviest atom of any natural element.

The Manhattan Project's plant, on the Columbia River at Hanford, Washington, is the world's greatest atom-making factory. Devoted entirely to the mass production of plutonium atoms, it uses U-238 as the raw material and U-235 as the energy source, intimately mixed in the same proportions as in natural uranium metal.

The production units at Hanford are several huge uranium "piles." Each is a very large block of graphite with holes in which are placed uranium-metal cylinders, sealed in aluminum cans to protect the uranium from corrosion by the cooling water constantly pumped through the pile.

Each pile runs itself, so to speak. Not even the conventionally pictured bits of radium, beryllium and paraffin are needed as a "pilot light" to start operation. There are always enough stray neutrons, or even cosmic rays, to start a chain reaction.

But once started, the design, size and control of the unit must be such that the chain reaction will continue at an even rate — neither die down nor overshoot into an explosion.

To see this picture in atomic terms, consider the fraction of a second in which one million U-235 nuclei are split, producing two million lighter atoms (say, one million of barium and one million of krypton) and between one and three million fast-moving neutron projectiles.

Some of these escape in free flight right through the relatively vast atomic "open spaces." Some are "captured" by the many U-238 nuclei, and others are captured by the impurities. But, on the average, of the one to three million, just one million neutrons must succeed in smashing another million U-235 atoms in the next fraction of a second. Thus, with reproduction rate exactly maintained, life goes on in the atomic-energy pile.

The carbon, one of several possible "moderators," serves to slow down the neutrons without capturing many. The chance of a fast, straight-moving neutron hitting a tiny nucleus is very small, whereas the "slow ball" neutron is likely to be sucked in by the nuclear attraction if it would otherwise be a near miss.

From the practical angle, maintaining a chain reaction requires careful design and good controls. The pile must be slightly larger than actually necessary for a chain reaction (that means scores of tons of material). Controls must be sensitive and dependable. They slow the pile down to the balancing point by sliding in retarders, such as strips of cadmium.

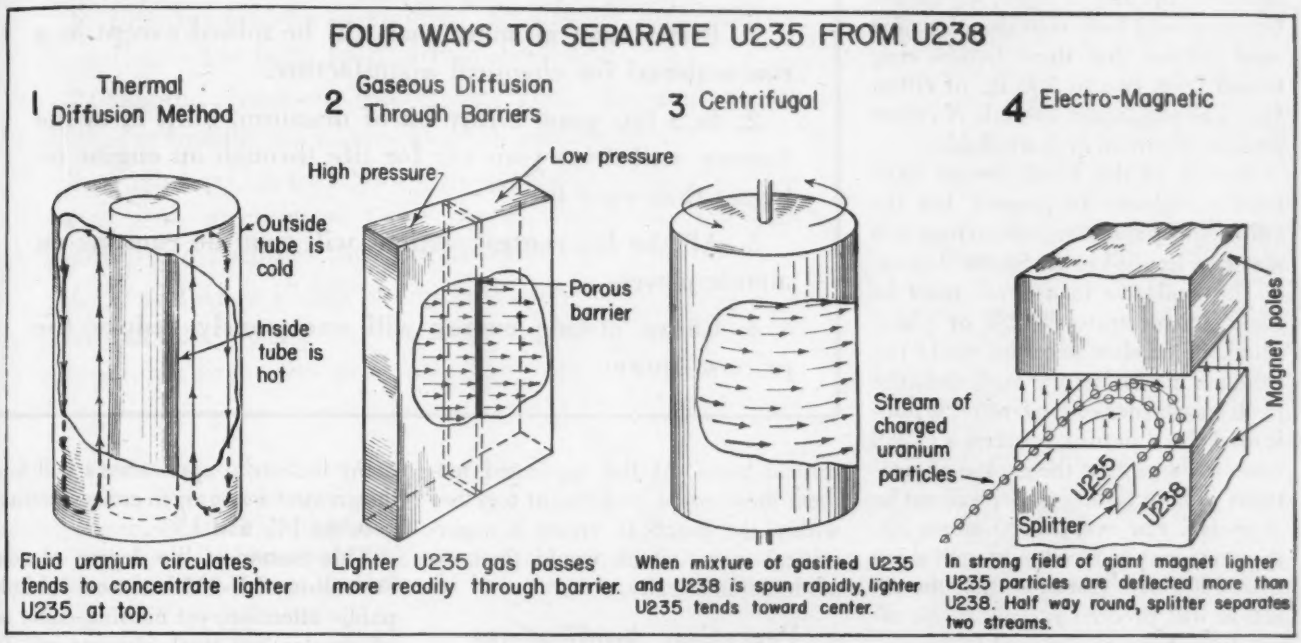
As already noted elsewhere, the energy released is about 11,400,000 kilowatt-hours for each pound of U-235 split. This energy appears first in the high speed of the pieces thrown off by the atomic split, then is converted to sensible heat as collisions slow down these projectiles. The energy is finally removed from the pile in the form of hot air, steam, hot water or other heated fluid in commercial quantity and thermal condition.

Such piles, operated with normal uranium, or with uranium enriched in U-235, would seem to be the primary means by which atomic energy will serve (if ever) as a commercial source of heat and power. Plutonium would be a byproduct, but might under certain conditions add to the energy yield of the pile without the need to separate it from the uranium.

The use of normal uranium in the Hanford pile sounds extremely attractive as a heat source, but has certain economic disabilities. Only a small part of the U-235 is used up before the pile must be shut down to remove the plutonium.

THE HIGH-POWER ATOMS

Isolating U-235 — a Gigantic Task


FOUR WAYS TO SEPARATE U235 FROM U238
1 Thermal Diffusion Method
2 Gaseous Diffusion Through Barriers
3 Centrifugal
4 Electro-Magnetic
Outside tube is cold
Inside tube is hot
High pressure
Low pressure
Porous barrier
Stream of charged uranium particles
Magnet poles
U235
U238
Splitter
Fluid uranium circulates, tends to concentrate lighter U235 at top.
Lighter U235 gas passes more readily through barrier.
When mixture of gasified U235 and U238 is spun rapidly, lighter U235 tends toward center.
In strong field of giant magnet lighter U235 particles are deflected more than U238. Half way round, splitter separates two streams.

Many of the uranium ores, including most samples of pitchblende and carnotite, will yield from 1 to 15% metallic uranium. Chemical separation of the metallic "natural" uranium is simple. Whatever the source, natural uranium contains the three isotopes in the constant proportions of 99.3% U-238 and 0.7% U-235, with traces of U-234.

Separating the U-235 from U-238, an operation essential for explosive uses of U-235, and probably important for future commercial controlled-chain piles, has been most difficult. Chemical separation was impossible because U-235 and U-238 are chemically the same.

The only possibility was a separation by physical differences, primarily a one percent difference in weight. The porous barrier and centrifugal methods pictured above required vaporizing a salt of uranium. All the methods shown have been used or tried on the Manhattan Project. All require many stages to achieve a substantial concentration of Uranium 235.

Dollarwise Thoughts on Atomic Energy

Costs mean little in war, but peacetime uses of U-235 and plutonium must pass the dollar test in competition with coal, fuel oil, natural gas, gasoline and electricity.

On the basis of energy costs only, "*all other things being equal*," the table on the last page of this section shows at what price per pound U-235 would give the same energy cost as conventional energy sources selling at the indicated prices. For such comparisons it is convenient to remember that one pound of U-235 is equal (energy-wise) to about 11,400,000 kilowatt-hours, also to 1500 tons of coal, or 200,000 gallons of gasoline.

Fuel engineers understand the limitations of such oversimplified comparisons. Others should be warned that "all other things" are never equal. With this thought in mind, reconsider the uranium piles operated at Hanford to produce plutonium. These use U-235 in the cheapest form, say about $1400 per lb., assuming purified normal uranium at $10 per lb. (140 lb. of uranium contains one pound of U-235.)

If this were the whole story, coal would have to sell for a dollar a ton to break even with U-235 as a water heater. However, the pile using normal uranium must be immense to hold its own in a chain reaction. More important, the accumulating fission products "poison" the reaction after only a small part of the U-235 has been used up. Then the uranium cylinders must be removed for plutonium recovery. Finally, it has not yet been found possible to operate the normal-uranium piles at high enough temperatures for practical power production.

If we go to the other extreme and build a small pile, using concentrated U-235, we shall run into excessive material costs, perhaps several times the $52,000 per lb. set down in the table as the equivalent of 20-cent gasoline.

Something between the two extremes is likely to prove the most economical — perhaps a pile operating on a U-235 concentration between 1 and 10%.

The engineer of the "atomic-power age" must know the price of Uranium 235 *in various concentrations* and the characteristics of piles suited to them. No such information is yet available. He must also watch the danger from radio-activity; the requirements for radiation shields; explosion hazards, etc.

CONTINUED ON NEXT PAGE

WHAT TO EXPECT

Before discussion of possible and probable future applications of atomic energy to the arts of peace, the atomic bombs should have consideration. We may assume that these bombs contained from two to 200 lb. of either U-235 or plutonium, or both. No more precise information is available.

Details of the bomb design have been completely suppressed, but the following basic considerations are stated or implied in the Smyth Report:

The explosive in a bomb must be highly concentrated U-235 or plutonium. Since slow neutrons could not produce a satisfactory explosion, the neutron retarder or *moderator*, is minimized. This, in turn, requires a U-235 mass so large that the escape of neutrons without hitting nuclei will not be excessive. For every 1000 atoms hit, the neutrons produced must split more than 1000 new atoms, so that the reaction will proceed rapidly in an expanding chain, as sketched below.

There can be little leeway in the size of the explosive charge. For a given shape there is a certain "critical" weight of material. If this is exceeded the bomb explodes instantly. If the weight of charge is less than the critical, it cannot be made to explode.

Therefore, the critical mass must be created at the moment of explosion.

The Smyth Report suggests that this can be accomplished by breaking down the charge into two or more well-separated parts, each having less than the critical mass. At the appointed moment these could be brought together within the bomb to create a supercritical mass, which would then explode automatically.

CLAIMS LIKE THESE ARE NOT JUSTIFIED

1. Pretty soon no more coal will be mined except as a raw material for chemical manufacture.

2. In a few years a tiny bit of uranium, built in at the factory, will drive your car for life through an engine no bigger than your fist.

3. All the big central stations will soon be running on atomic power.

4. Cheap atomic energy will enormously reduce the price of power.

Peacetime Applications

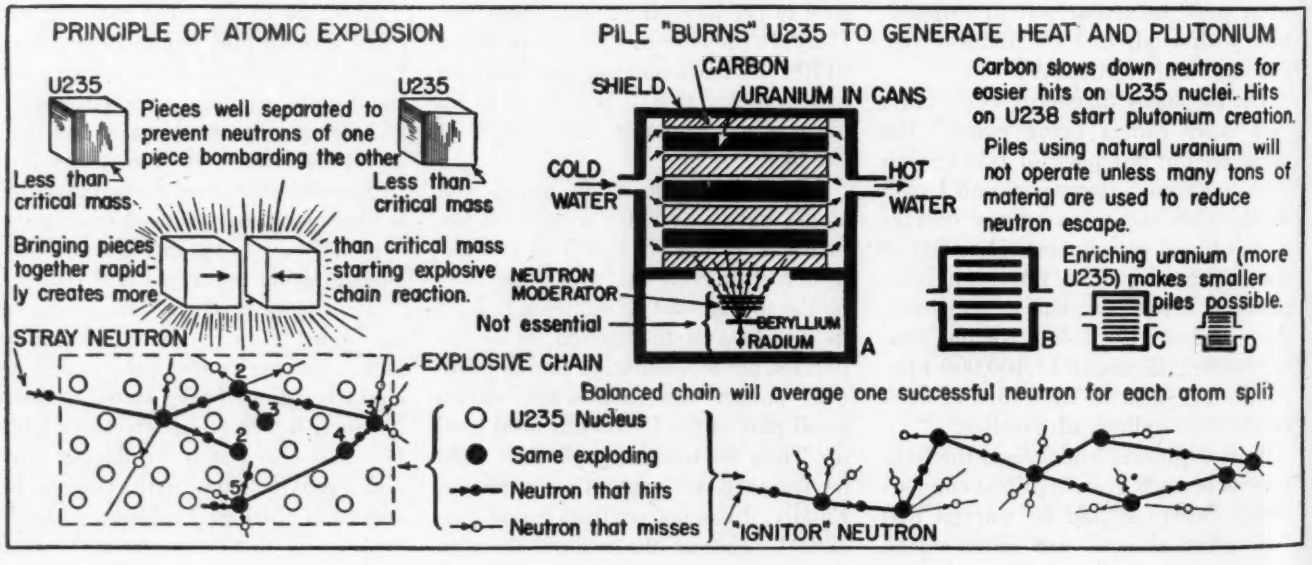
Except possibly for superblasting operations, uncontrolled explosive reactions cannot be permitted in the peacetime use of atomic energy. This means that the quantity of U-235 assembled in any one spot must always be kept well below the critical weight to avoid spontaneous explosion.

Depending on the particular application, the most desirable concentration of U-235 may range anywhere from the 0.7% in normal uranium up to 100%, with the probability that many industrial applications will find the greatest economy in concentrations between 1% and 15%.

This matter of the degree of concentration of U-235 has received little public attention, yet nothing could be of greater practical importance. To make this point clear, consider the two extremes, 0.7% of U-235 and 100% of U-235, respectively.

The Hanford pile, using normal uranium (0.7% U-235) with carbon moderator, must be very large to work at all. It is inefficient in the sense that it must be shut down after a small part of the U-235 has been consumed. It cannot operate at high temperatures.

Its great advantage as a heat producer is the fact that its U-235 is bought at the lowest possible price. If


PRINCIPLE OF ATOMIC EXPLOSION
U235
U235
Pieces well separated to prevent neutrons of one piece bombarding the other
Less than critical mass
Less than critical mass
Bringing pieces together rapidly creates more than critical mass starting explosive chain reaction.
STRAY NEUTRON
EXPLOSIVE CHAIN
PILE "BURNS" U235 TO GENERATE HEAT AND PLUTONIUM
SHIELD
CARBON
URANIUM IN CANS
COLD WATER
HOT WATER
NEUTRON MODERATOR
Not essential
BERYLLIUM
RADIUM
A
Carbon slows down neutrons for easier hits on U235 nuclei. Hits on U238 start plutonium creation.
Piles using natural uranium will not operate unless many tons of material are used to reduce neutron escape.
B
Enriching uranium (more U235) makes smaller piles possible.
C
D
Balanced chain will average one successful neutron for each atom split
U235 Nucleus
Same exploding
Neutron that hits
Neutron that misses
"IGNITOR" NEUTRON

FROM ATOMIC ENERGY

. . . BUT REMEMBER THESE FACTS

1. The large-scale, controlled release of heat energy from U-235 has been fully demonstrated.

2. Beyond question, this energy could be applied directly for heating water and air, and making steam.

3. Such heat, in turn, could be applied directly, or converted into mechanical power or electricity by conventional steam turbines and gas turbines.

4. If and when U-235 in concentrations up to 10% costs less than $25,000 per lb., it may find applications, but will compete, at first, with premium fuels rather than coal.

purified normal uranium sells for, say, $10.00 per lb., the price of 140 lb. (containing one lb. of U-235) will be only $1400. This would be a very favorable price if the pile could operate efficiently with the 0.7% U-235.

Concentrating the U-235 to 100% would permit a much more compact and convenient pile — perhaps little more than small pieces of U-235, encased in aluminum to ward off corrosion, and immersed in a tank of water; this should convert the water into steam at a regulated rate.

In large part, the control would be inherent. The water as a moderator would keep the chain going, but if the reaction got too violent, the resulting higher superheating of the steam would decrease the moderator effect and thereby hold the reaction in check. Yet even if all this comes true the cost of concentrated U-235 in the near future will be many times $10,000 per lb.

Running up the concentration only a few percent above that in normal uranium may prove to be the way to get reasonable pile size and good efficiency without incurring exorbitant concentration costs.

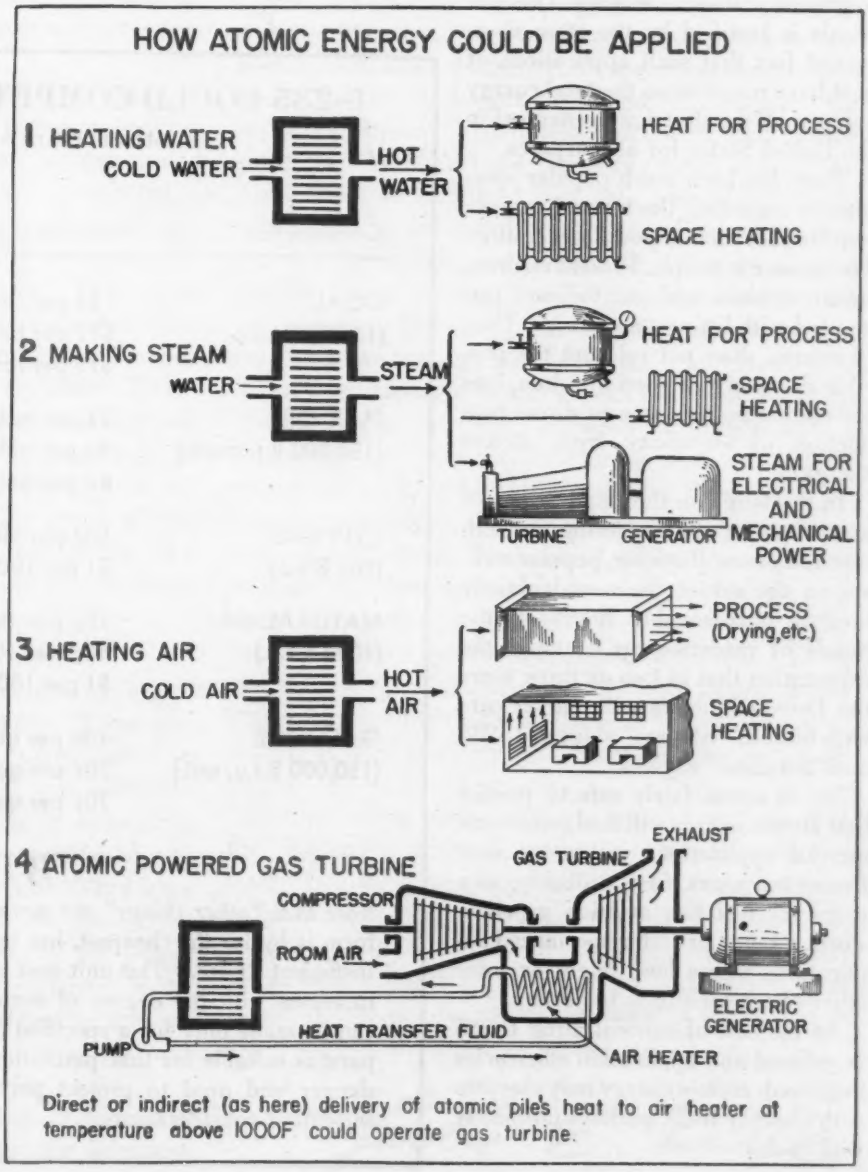
When atomic energy is applied, the starting point is heat, picked up by water, air or a special heat-transfer fluid. Intermediate heat transfer fluids may be essential in certain applications (space heating and service water, for example) where people must be protected from injury by radioactivity.

The intermediate heat-transfer fluid shown for the gas turbine would, of course, have to operate at temperatures up to 1200 F. There seems to be no basic reason why the pile itself could not be built inside the compressed-air receiver, discharging its heat directly to the compressed air.

With rather high concentration of U-235, this arrangement might be suitable for large airplane drive if excessive weight of radiation shields could be avoided.

Also, presumably, rockets and planes of the "buzzbomb" type could be powered by atomic heat delivered to the air of the jet steadily, not in puffs.

The sketches stress direct applica-



Direct or indirect (as here) delivery of atomic pile's heat to air heater at temperature above 1000F could operate gas turbine.

THESE THINGS MIGHT RESTRICT USE OF ATOMIC ENERGY

1. Ineffectiveness of large piles using normal U-235 concentration

2. High cost of concentrated U-235 for smaller, more effective piles

3. Danger from radioactivity

4. Weight and cost of shielding against radiation

5. Explosion hazard

6. Possible short supply of uranium

7. Governmental restrictions on atomic-energy materials

tions of hot air, steam and hot water to process and space heating. This emphasis is justified by the often overlooked fact that such applications of heat have many times the total energy value of all the electricity generated in the United States for all purposes.

There has been much popular speculation regarding the type of engines required for atomic-power generation. The answer is simple. Present engines, steam turbines and gas turbines can be used with little or no change. This, of course, does not rule out the possible discovery of specialized engines for atomic power, or even direct production of electricity from atomic energy.

In the long run the implications of atomic power are staggering for both war and peace. However, popular writers on the subject have undoubtedly created unreasonable hopes in the minds of readers — for example, the expectation that in two or three years the Detroit builders will market cars with built-in "lifetime" slugs of U-235 and "fist-sized" engines.

Yet it seems fairly safe to predict that atomic energy will find some commercial applications within the next five or ten years, first, probably, as a premium fuel like aviation gasoline, worth a fancy price for specialized applications where low weight or some other characteristic is important.

As the cost of concentrating U-235 is reduced and application efficiencies improved, atomic energy may compete with cheaper fuels, perhaps ultimately with coal.

Important non-power applications of atomic energy may well include the ultra-high-temperature processing and fabricating of materials — also, modern "alchemy": building and rebuilding atoms to create new elements and to produce old elements at lower costs.

Radioactivity obtained directly or indirectly from artificial atom-splitting should find many important medical and industrial applications.

Turning back to ordinary power applications, we must avoid the temptation to overstress the economic importance of lower-cost power fuel. Fuel cost is only about 17% of the gross receipts of the electric utilities. Here's another way to put it: If, after allowing for transmission losses, one kilowatt-hour delivered to the consumer from modern plants represents a coal consumption of 1.5 lb., and if the coal costs $5.00 per ton cancellation of the coal bill could not save more than ⅜ of a cent per killowatt-hour. And atomic fuel will certainly not be free.

Performance of the atomic bomb is a monument to the scientists who unlocked the secrets of the atom and suggested the basic technique of making plutonium and concentrating U-235.

From there on, the job was at least 50% engineering. The various big plants of the Manhattan Project are vast assemblages of pipes, tanks, boilers, valves, instruments and controls, installed and operated by engineers, largely designed by engineers. From now on, the speed with which atomic power becomes practical will depend on the effectiveness of the engineer-scientist team.

It is possible, of course, that national controls may completely upset the entire technical and economic pattern of this discussion. For reasons of national security the government may decide to control or restrict atomic-power materials, plants and operations in ways not yet determined.

U-235 COULD COMPETE AT THESE PRICES

other things being equal

Common fuel	*Assumed prices*	*Comparable prices for Uranium 235, dollars per pound (nearest thousand)*
COAL	$6 per ton	$9,000
(13,000 B.t.u.)	$12 per ton	$18,000
	$15 per ton	$23,000
FUEL OIL	2¢ per gal.	$5,000
(150,000 B.t.u. gal.)	4¢ per gal.	$10,000
	8¢ per gal.	$20,000
CITY GAS	50¢ per 1000 cu. ft.	$39,000
(500 B.t.u.)	$1 per 1000 cu. ft.	$78,000
NATURAL GAS	25¢ per 1000 cu. ft.	$10,000
(1000 B.t.u.)	50¢ per 1000 cu. ft.	$20,000
	$1 per 1000 cu. ft.	$40,000
GASOLINE	10¢ per gal.	$26,000
(150,000 B.t.u. gal.)	20¢ per gal.	$52,000
	30¢ per gal.	$78,000

BUT

Note that "other things" are never equal. U-235 in normal uranium form is by far the cheapest, but involves use of excessively large and inefficient "piles." The unit cost of the U-235 in enriched mixtures increases with the degree of enrichment. Over-all cost comparisons can be made only for a specified concentration of U-235 and for apparatus suitable for that particular concentration. Possible explosion danger and need to protect personnel against radiation are other important considerations.

EDITORIAL

Split Elements—And Human Elements

THE WAR IS ENDED and the manner of its ending gives us cause for sober thought. The use of old-concept force has been terminated by the application of a far greater force. The circumstances were such that this terminating force was in benevolent hands. The holocaust of Hiroshima could have occurred at New York, Washington, or Chicago. We won the war decisively because we won a scientific race in which each major nation had been engaged for many decades. We won the race because we marshalled our resources in time, under able generalship, and an element of Providence. And we won it because we did not make the mistake of impairing scientific development by racial or religious prejudice.

The all-star cast of research workers who brought about the harnessing of atomic energy is as cosmopolitan as America itself. Citizens of France, Germany, and Italy, members of various religious faiths, contributed to the American accomplishment. There could be no more dramatic proof that no individual nation is possessed of superior brain power, not even our own. The eternal struggle of all mankind to harness nature so transcends our military exploits that only by mutual accord among nations can we now save the world from destruction.

It is still too early to evaluate the destructive or constructive value of this discovery as revolutionary as that of fire. It took centuries for us to rise to its initial application and control and it will take years of well organized research to bring to full fruition the new atomic age. In the meantime we must strive to maintain our sense of values.

WE MUST REMEMBER that it required airplanes to carry atomic bombs to their targets. Those airplanes required fuel, oil, men, and bases from which to operate. The bases were established by a combination of air, sea, and land power, including a substantial quantity of human blood. They were maintained and manned by the use of the merchant marine. They were supplied by perspiration and ability in the home-front industries. And so the basic elements of air power remain much the same. Time will bring changes in the proportions of the fundamental ingredients, but we must not make assumptions about the new proportions until all the facts are in hand.

We must not let the sudden ending of hostilities deter us from the resolution to maintain our dominant air power in all of its phases. Immediate steps must be taken to prevent the disintegration of the industrial organization and collective talent which has made victory possible—until a long term air policy is developed.

Most serious immediate problem confronting our aircraft manufacturers is the danger involved in sudden termination of their Army and Navy contracts. The disorderly deflation of the industry would cause irreparable damage to the industry. It is most urgent that sufficient time be given the contractors to adjust their operations to postwar levels.

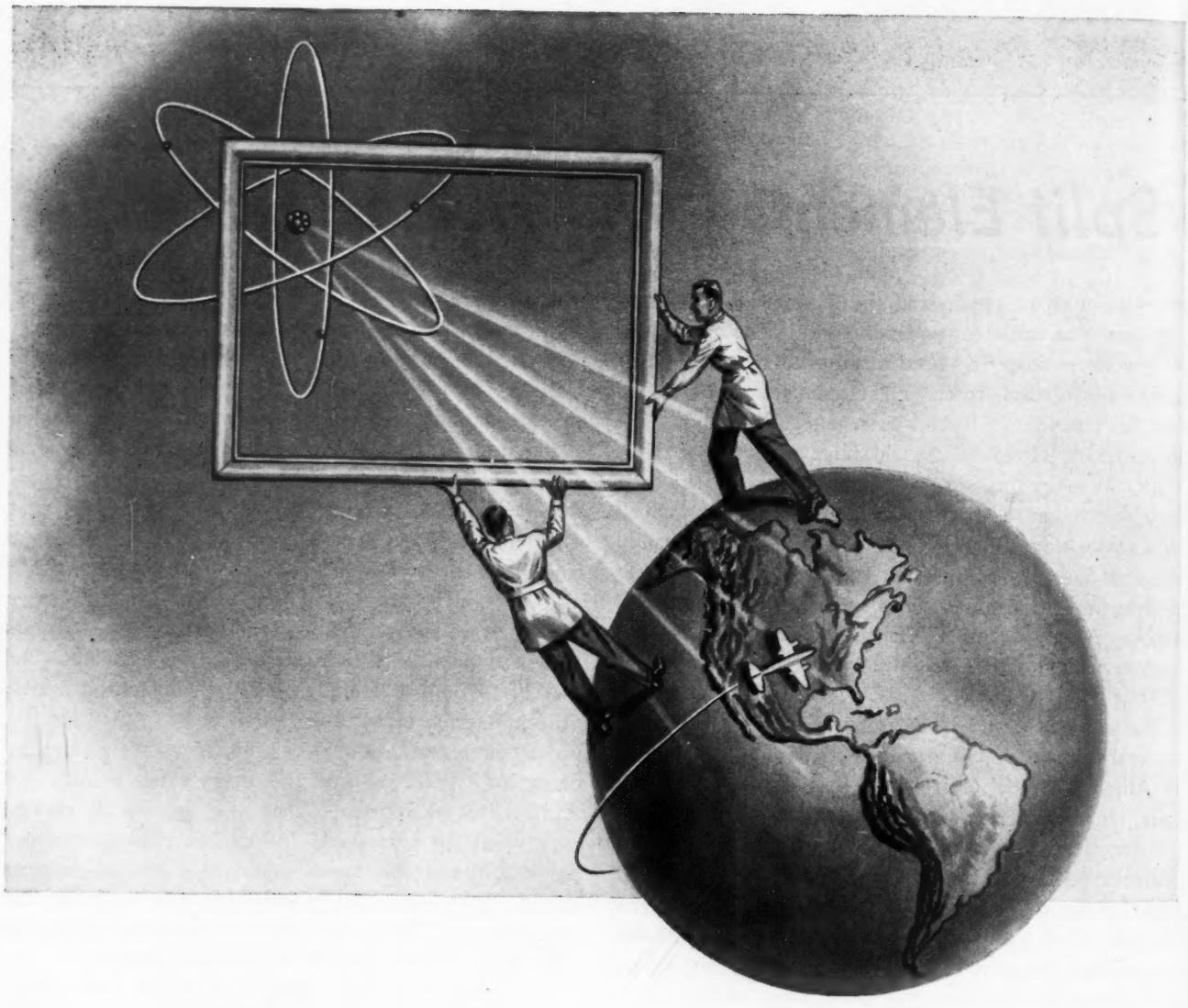
AT A TIME LIKE THIS it seems hardly necessary to re-emphasize the importance of continuous research. We must strongly resist any inclination to rest on our laurels, or to interrupt even for a moment the important research and development work that is now going on. We have said this many times before. In April 1943 we intimated that new sources of energy soon would be unleashed. In October 1944 we pointed out that the atomic bomb would be a symbol of even deadlier things to come. It is folly to rely on secrecy for our security. The world will be safe from destruction only while we are ahead of the scientific parade.

Our civilization now finds itself at the crossroads. We may move on toward self-destruction or toward a better life for everyone. Assuring that we are big enough to control the forces we have discovered, we must brace ourselves for many changes in our economic and our social lives. We must be willing to accept new relationships between government and industry, between management and labor. We must provide better balance between production and distribution. These and many other changes were inevitable before atomic energy appeared upon the horizon. They will be accentuated as the new scientific development begins to unfold.

The preceding pages contain a realistic evaluation of the significance of atomic power. On the pages immediately following are glimpses of its possible applications in the aviation field. Additional material on this subject will be published as rapidly as it becomes available. These facts will give us the necessary background upon which to base our important decisions in the period of major adjustment that lies ahead.

Leslie E. Neville

EDITOR



The Atomic Frame of Reference —Or Else

By HERB POWELL, *Associate Editor, "Aviation"*

NO LESS THAN IT awed the man-in-the-street, the disintegration of Hiroshima under the blinding blast of an atomic bomb likewise awed the man-in-the-aviation-industry. This, despite the fact that he has commonly taken in stride a full wealth of wonders in his own field. However, a month has now elapsed in which to rebuild mental fences, and today, at least, some of the pertinent factors are shaping up into a new, if still only makeshift, perspective.

Above all, Hiroshima must be taken as an ultimatum—first, to quickly fit our thinking to encompass the new military and politico-international concepts entailed by this airborne weapon; second, to keep these concepts lined up with all obtainable facts by vastly broadening our researches. Merely persisting in our investigations is hardly enough, for the pace of past industrial research is already an outworn criterion.

How shall we guide our thinking? On this score, suppose that we attempt a three-way differentiation of the bald facts, impending realities, and theories for the future, mirroring the consensus of authorities at this transitional stage of the fission development.

I. The Bald Facts

What the atom bomb can do is clearly evidenced by the accompanying photos of Hiroshima, and meanwhile the details of its power in contrast with older forms of explosives have been printed at length. Moreover, it has been noted that the bomb which later hit Nagasaki was even more powerful than the first, also easier made.

There is no doubt, either, that this force can be maintained by a possessor nation; for in spite of it being "A $2,000,000,000 gamble that was won," such costs are cheap in terms of war,

Explosive transmutation of the atom—abruptly giving us the superpower to devastate whole cities in single fell blows—must be followed in all haste with immediate transmutation of our thinking. Initial facts demand drastic revision in old military means and methods. And in the impending future loom further revolutionary realities—which quickly and practically must be integrated into our revised concepts if we are to avert fatal missteps.

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and the manpower and materials are available. Besides, such costs and manpower would tend to decrease. With the force and its maintenance being demonstrated, the cynical philosophy is expressed that "Man may be out-thinking, out-smarting, and out-inventing himself." But man may have always been doing that, atom bombs or not.

Then the dark philosophy goes that "The extermination of mankind is now no mere figure of speech." But unless the whole world is blown up, the eskimos will likely go on as before. And even if we say "civilization" instead of "mankind," then the "civilization" winning the atom war might well carry on in some manner. Let's simply say that man's death-dealing and military powers have been dangerously expedited, calling that our bald fact.

Some gage of this power is already available in the following facts: These bombs definitely cut short Japan's staggering and brought her quickly to her knees; given the bomb earlier, D-Day in Normandy certainly could have been a greatly minimized operation, if it were not made unnecessary altogether; in the present status, the possessor nation could obliterate all enemy major cities and war-production sites, thus decidedly shortening a war; also, major wars are surely less likely between non-possessor and possessor nations, and, again, offense remains the best defense in this period where defense has not caught up, noting that even such weapons as the V-1 and V-2 were not balanced by defense.

But what if mankind bans this terrible weapon? To that we may say, "Don't you believe it." True, some morally inclined nation might not *want* to use it, but the fact that it could shorten a war and save many lives of its nationals would knock such a "ban" into a cocked hat. The case of gas warfare doesn't offer a comparison, since gas has never really been under a true ban, and warring nations have merely found gas impractical. Then, too, such devices as the flame thrower are as reprehensible.

Aviation had already contracted the world to make the precepts of isolationism untenable; this new air-carried bomb calls for the quick funeral of that isolationism. Only three months ago, Gen. Gamelin contended that the Maginot Line played a role in detouring the 1940 Germans to the north and to the south. But the atom bomb has abruptly wound up that idea and gone on to necessitate new concepts of buffer states, of boundaries both natural and man-made, even of treaties and alliances. Geopolitics was actually a last gasp of the old ideas. It taught not of nations but of land masses. Yet today, even vast land masses fade in strategic value before modern air power which can toss atom bombs anywhere on the globe.

The viewpoint of the public is likewise a pertinent factor in the atom concept of air power. Had New Yorkers, Washingtonians, Bostonians, and Philadelphians really known the all-out devastating power of the atom bomb

(*Continued on page* 244)

HIROSHIMA BEFORE . . .

. . . AND AFTER

Amazing demolition wrought by initial A-bomb is graphically illustrated by these comparative views. But for a "stray" building here and there, nothing now remains of what was once heart of teeming city. Right photo shows only a fraction of more than 4 sq. mi. (60%) which was wiped out. Key targets known to be annihilated were two power stations, two railway centers, a mill, a gas works, and a telephone company, as well as several bridges. And virtually every other plant in atomic-blast area was in great part disintegrated. To get maximum effect against buildings, bomb is fused to detonate at a specific height above the ground. It appears, however, that improved atomic missile dropped on Nagasaki fell lower than intended. As a result, it gouged out a tremendous crater, damage being gaged at 30% of city's area. (P. A. photos)

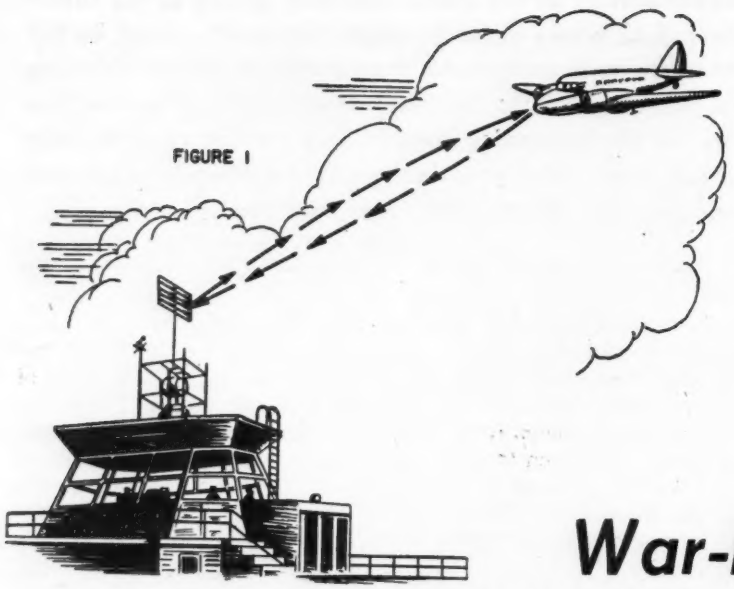


FIGURE 1

Lifting of the security veil permits this revealing discussion of radar. . . . An authoritative consideration of the operating principles of this great military aid and how it can increase aeronautical utility, comfort, and safety.

War-Developed Radar Promises Swift Peacetime Progress

By H. C. LAWRENCE, *Radio Corp. of America*

WITH THE WAR'S END it is possible to reveal some of the long-suppressed technical details and to estimate the potential peacetime aeronautical uses of radar.

Radar was an important factor in winning the war; it will be an equally important factor in the safety of civilian aviation, and in the speed with which air traffic can be handled at crowded airports which will result from increased civilian flying.

The name "radar" is derived from the words *Ra*dio *D*etecting *a*nd *R*anging. It is a whole family of equipment types rather than one specific piece of equipment. This family of equipment includes all radio echo devices.

In operation, a radar system sends out short pulses of radio energy in the direction to be explored, as shown in Fig. 1. If these pulses of radio energy encounter a reflecting object, such as an airplane, some of the energy is reflected back toward the transmitting location, where a receiver picks up the reflected energy. The time required for the pulses of radio energy to travel from the transmitter to the reflecting object and back again to the transmitting location is then measured. With the speed of radio waves known, it is possible to convert the time of travel into the distance of the reflecting object. Modern radar equipment is calibrated directly in terms of distance. The direction of the reflecting object is determined from the direction in which the energy is sent out and received.

A block diagram of a representative radar system is shown in Fig. 2. A transmitter generates pulses of radio frequency energy. The transmitter frequency is normally several hundred megacycles, often several thousand. The pulses of radio-frequency energy are of the order of one microsecond (one one-millionth of a second) in duration, are usually repeated at a rate of several hundred per second.

A sensitive radio receiver receives the reflected energy. Separate transmitting and receiving antennas, as shown in Fig. 2, are often used, although a common antenna is used in many installations to save space and weight. A common transmitting-receiving antenna requires the addition of a duplexer unit as shown in Fig. 3. The duplexer prevents transmitted energy from damaging the receiver, and keeps the received energy from reaching the transmitter. The antenna system is normally constructed so as to concentrate the radio energy into a narrow beam.

The receiver is connected to a distance indicator which measures the time required for pulses to travel to the reflecting object and return. Since the time required for radio energy to travel 10 mi. and return is approximately 100 microseconds, the distance can be made to appear on a conventional meter dial in some very simple types of radar systems. Most frequently, however, the distance (and even direction) appears on the screen of a cathode-ray tube, which is a more versatile indicator than a simple meter. Several reflecting objects and their directions can be indicated simultaneously.

A cathode-ray tube is a special type of vacuum tube incorporating an electron gun which directs a fine stream of electrons toward a luminescent screen coated on the inside of the enlarged end of the tube. This screen produces a bright glow where hit by the electron beam. Voltages can be applied to the two pairs of deflection plates to direct the electron beam to any point on the screen.

The simplest type cathode-ray tube indication is shown in Fig. 5. This pattern appears as a green or white line on a dark background. The cathode-ray tube beam is moved rapidly across the screen from left to right, moving so fast that it appears as a line of light on the screen. A new line is started each time a pulse is transmitted. A "pip" appears at the left-hand end of the horizontal line, indicating the transmission of a pulse. Reflected pulses picked up by the radar receiver causes other pips to appear at distances from the left-hand end of the trace which correspond to the respective distances of the reflecting objects.

Each pip represents a reflecting object. To the eye they appear to be continuously present because of the great number of pulses transmitted each second and the persistence of vision.

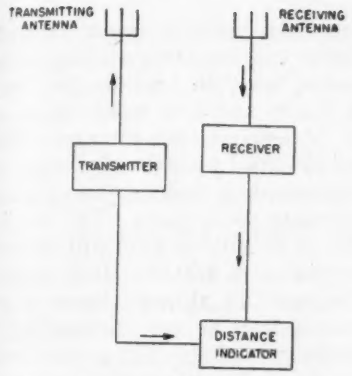


FIGURE 2

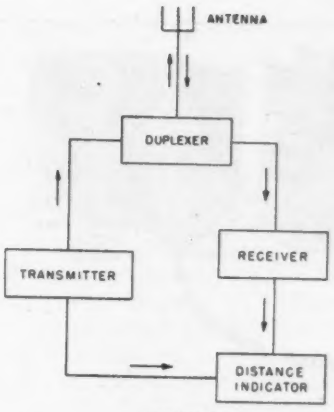


FIGURE 3

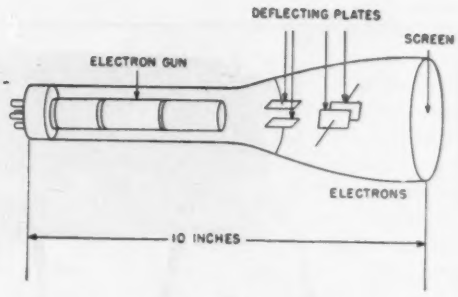


FIGURE 4

The distance of the reflecting objects is read on a scale below the trace. Direction of the reflecting objects in this type of indication is determined from the direction in which the beam antenna system is pointing.

A map of an area showing the distance and direction of all reflecting objects, such as airplanes, hills, land, etc. can be presented by a Plan Position Indicator, or PPI. This type of indication is formed on the screen of a large cathode-ray tube, the beam of which starts at the center of the screen and moves rapidly outwards towards the edge. A new line is started each time a pulse is transmitted (Fig. 6). The direction of travel of the beam from the center of the tube coincides with the direction in which the antenna is pointed at that time. The intensity of the cathode-ray tube beam is so adjusted that only a faint line appears on the screen of the tube. A signal returned from a reflecting object them causes the line to become bright at a point corresponding to the distance of the reflecting object. The radar beam antenna system and the line on the tube are then rotated in synchronism to explore all directions of the compass to produce a pattern which is easy to interpret. Large reflecting objects, such as cities and masses of land, produce large indications showing their actual shape.

During the war radar equipment has been used to detect enemy aircraft and measure its distance, direction, speed, and altitude, both from ground stations or other aircraft, to warn airplanes of the approach of other aircraft or an obstruction, as absolute altimeters, and to control guns, searchlights, fighter planes, and bombers. Some of the war applications, and even war equipment, can be adapted immediately for civil aviation. Other military applications will never be used by civilian aviation, however, because the military application has no civil counterpart (gun directing, for example) or because size, weight, and operating personnel required make the application uneconomical; also, many military radar applications are based on the principle that an enemy is not going to help you locate him.

Civil aviation, on the other hand, can be made cooperative, by the installation of simple types of radio equipment and the application of flying regulations, making it unnecessary to provide the large amount of aviation radar equipment needed for military purposes. Seen coming are peacetime aviation applications of radar with no present military counterpart.

FIGURE 5

FIGURE 6

Army and Navy radio altimeters undoubtedly will be used in their present form by many commercial air lines. In the more distant future, radio altimeters may become standard equipment, even in private planes. Radar altimeters show the actual height above ground, rather than the height above sea level or some other predetermined level as do barometric altimeters. When flying at high altitudes the pilot or navigator need not make air temperature or barometric corrections of the radio altimeter readings. A radio altimeter and barometric altimeter can be used together to obtain corrected barometric readings for weather purposes over long ocean routes.

Two types of radio altimeters are now in general use, one of which is shown in Fig. 7. Known in the Army as the SCR-718-C, it weighs approximately 34 lb. installed. The left-hand unit contains a small radar transmitter, receiver, and the necessary power supply equipment. The right-hand unit is a cathode-ray tube indicator and control unit. This indicator has two scales: one for 0 to 5,000 ft., the other for 0 to 50,000 ft. The desired scale is selected by a switch next to the indicator tube.

Operation of the equipment is illustrated in Fig. 8. Radio pulses from the transmitting antenna travel to the ground and are reflected back to the receiving antenna. The time of travel is measured and converted to distance by the indicator.

Altitude indication is a modification of the pattern shown in Fig. 5. The line on the cathode-ray tube is made circular instead of straight, to obtain greater scale length on a small screen, and the indicating pips appear around the circle. The pip at the zero position is a reference and will remain at the zero position when the equipment is operating properly. The pip shown at 3,500 ft. is the pulse reflected back from the ground and indicates the height of the aircraft.

An experienced operator can judge the nature of the terrain below the

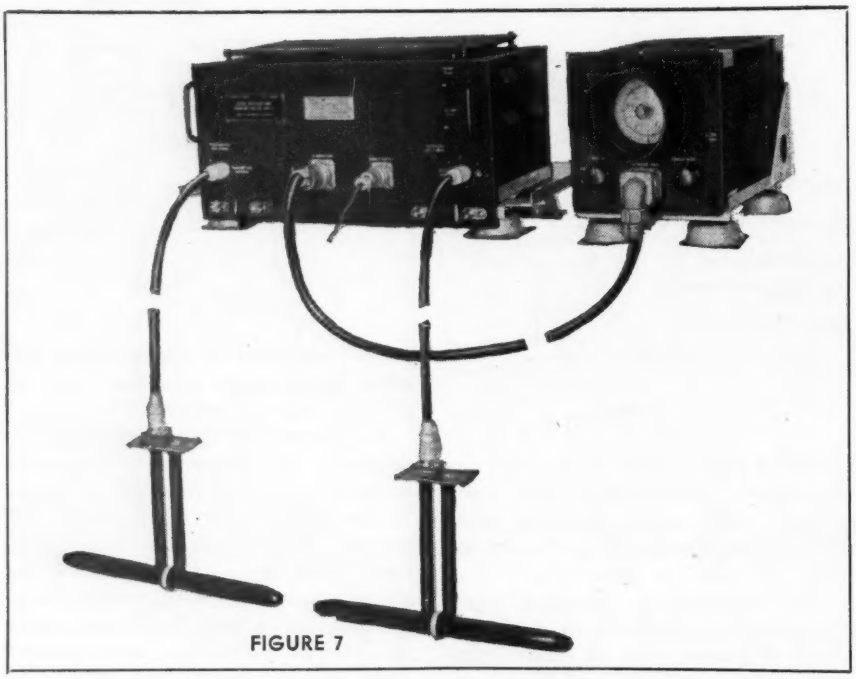


FIGURE 7

airplane by the nature of the indicating pip, for flat ground, water, cities, and mountainous terrain all give characteristic indications. The cathode-ray tube has the advantage that an operator can instantly recognize improperly operating equipment.

The second type of radar altimeter, Army-Navy AN/APN-1, is shown in Fig. 9. This equipment weighs approximately 35 pounds installed. The large unit contains transmitter, receiver, power supply and measuring circuits. The small unit on the right in the illustration includes the indicating meter and control switches. The other two small units are altitude selector switch and indicator light unit. The large unit is located at a remote point, and the three small units are mounted on the instrument panel as shown in Fig. 10. This altimeter is available in single- and double-range models, with altitude ranges of 0 to 400 and 400 to 4,000 ft.

This type presents its indication on a meter which is easily read in bright light, but the inertia of the meter movement eliminates most of the possibility of judging the nature of the terrain below, as can be done with the inertialess cathode-ray tube indication.

An altitude limit switch allows automatic altitude control of a plane. The switch is merely set to the desired altitude. The indicator lights are included to inform a pilot of his altitude with respect to the desired altitude.

This altimeter operates on a slightly different principle from the first unit described. The transmitter sends out a continuous radio-frequency signal whose frequency is continuously shifted up and down over a narrow frequency band at a low audio frequency rate (frequency-modulated). Some of the radio energy travels directly to the receiving antenna and some of it travels to the ground whence it is reflected back to the receiving antenna.

The energy that travels to the ground and back is delayed in time with respect to the energy going directly to the receiving antenna. Since the frequency of the transmitted signal is continually changing with time, there will be a frequency difference between the reflected and directly received signals, the difference being proportional to the altitude. Frequency-meter type circuits measure this difference and cause the meter to indicate the plane's exact altitude.

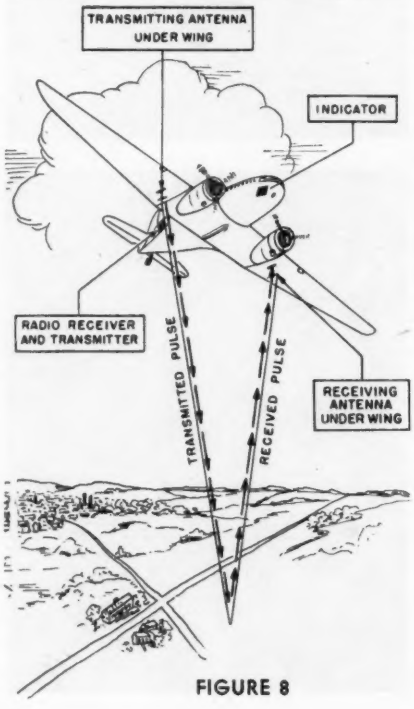


FIGURE 8

Pulse and frequency-modulation altimeters are both used by the Army and Navy, and both types will probably be used in civil aviation. Both were designed by RCA and each has certain features making them suitable for certain applications. The fm altimeter in its present form will measure altitudes up to 4,000 ft. It is particularly useful at altitudes below a few hundred feet, as are encountered in instrument landing. The present pulse type altimeters will not read accurately at very low altitudes, but they can be used at the high altitudes encountered in stratosphere airline operations.

Although present pulse altimeter models display their altitude readings on a cathode-ray tube, it is probable that meter or dial indicators will become available for use when the advantages of cathode-ray tube indicating are not desired.

Navigation Aid Seen

Several radar navigation systems have been developed for wartime use. Some of them, particularly the high precision bombing systems, are heavy and complicated, and require highly trained operators. They probably will not find general civilian applications, except possibly in aerial map making. Furthermore, most of the high precision systems are relatively short-range devices that can be easily replaced by much simpler vhf two-course or omnidirectional radio ranges since it is no longer necessary to fly over enemy territory. The ranges are simple to use, and the equipment in the airplane is much lighter weight than radar equipment used for the same purposes.

A long range navigation system, Loran (derived from the words *Lo*ng *Ra*nge *N*avigation) is useful on ocean routes, and long routes over uninhabited territory where it is impractical to establish radio range systems. It is already well established on the worldwide air transport routes of both Army and Navy. The equipment is not unduly large nor heavy for long distance commercial airline routes, and can be easily operated by a navigator. Loran equipment will undoubtedly be used on such commercial airline routes, although details of equipment and operation are still being withheld for security reasons.

Blind Landing Systems

Some present ground and airborne radar systems can be applied to blind landing, but here again there are simpler non-radar systems that place the heaviest equipment and maintenance

burden on the ground instead of in the plane. Versions of the present blind landing systems providing runway localizer and glide path beams will continue in use for some time. A radio altimeter may be used as an altitude check during the landing process.

Collision Prevention

Collision prevention is one of the most often suggested civil radar applications. To be useful as a collision prevention device, a radar system must not only detect the presence of an airplane and determine its distance, but it must also determine the altitude of the detected airplane with respect to the airplane carrying the detector, and determine the direction in which the detected airplane is traveling. Furthermore, the equipment should automatically warn the pilot of impending danger and not require continuous attention of an operator in the airplane. All of these requirements must be met by a system requiring only lightweight airborne equipment.

Some of these requirements can be met by airborne radar equipment similar to that now in use; others cannot. A PPI installed in an airplane will show the distance and direction of other airplanes, but not their altitudes. A small auxiliary radio transmitter connected to an altitude measuring instrument installed in all airplanes could furnish the altitude information. (Such a device for automatically broadcasting altitude readings was considered by the CAA several years ago.) The combination of the two devices could furnish all of the information needed, but the full attention of an operator in the airplane would be required.

A modification of the altimeter shown in Fig. 9 conceivably could be connected to a directional antenna system arranged to search the area in front of the airplane and give audible warning of the presence of an airplane within this area. Unfortunately, however, the area searched can not be shaped to include all danger areas and yet not include large safe areas, and the speed and direction of travel of another airplane would not be given to the pilot. Inclusion of large safe areas and the absence of the speed and direction information necessary to avoiding a threatened collision make this approach seem unsatisfactory.

The difficulties of obtaining a light weight, completely airborne unit providing a dependable, easily read danger indication to a busy pilot are at present so great that many engineers have concluded that collision prevention can best be handled from the ground. Weight, size, cost and the necessity of a special operator are not as great problems in a ground installation as in an airborne installation. A ground collision prevention control system could be similar to a radar airport traffic control system, the ground control operator directing the aircraft in the vicinity by the normal radio-telephone communication system.

Airport Traffic Control

Radar will greatly increase the capacity of large airports by simplifying and speeding up traffic control. A PPI may be installed in the control tower and the radar system adjusted to show positions of all planes within the controlled area. A transparent map showing runways and nearby landmarks placed over the cathode-ray tube indication would facilitate directing incoming planes. Fixed objects, such as hills and water towers, giving indications on the PPI, can be marked on this map.

The pilot of an airplane approaching a radar-controlled airport can push an identification button on his instrument panel and cause a coded signal to appear near the indication that represents his plane on the control tower indicator. The identification equipment carried by the aircraft may be a simplified version of present military equipment and should not weigh over 20 lb. Each airline or type of service can have its own code. The airport control operator can then call the approaching plane when he is ready for it and get the plane's altitude and give any special landing information needed. Auxiliary radar equipment can determine each plane's altitude directly from the control tower if the additional service rendered can be shown to be worth more than the added complexity.

Speed of Adoption

The speed with which radar is applied to civil aviation will depend on the availability of equipment, which in turn will depend upon the speed with which reconversion can be achieved. Radio altimeters and Loran equipment are already being used by many airline operators on their Army and Navy contract routes. These two types of radar will be the first to become available for use on commercial planes. A few of the larger private planes will install radio altimeters soon after it is done by the commercial planes, but weight and cost of the equipment will be difficult to justify in small and medium size private planes. Airport traffic control equipment will probably be the next civil radar application, for the CAA is already conducting experimental work with this use in mind.

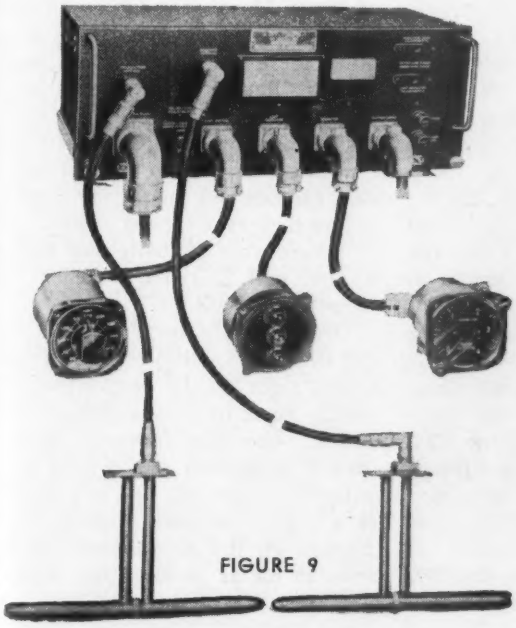


FIGURE 9

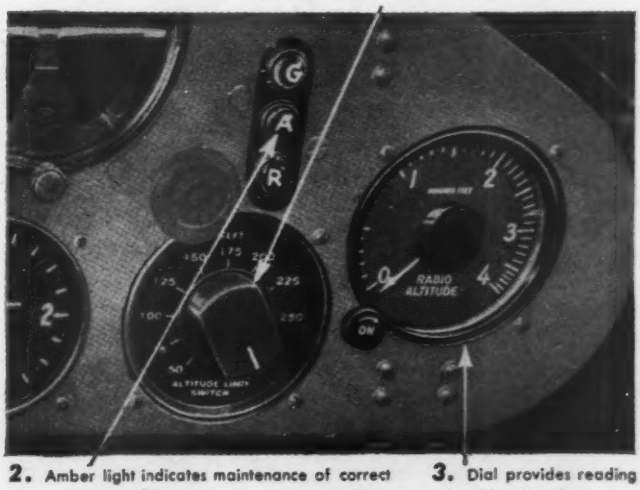
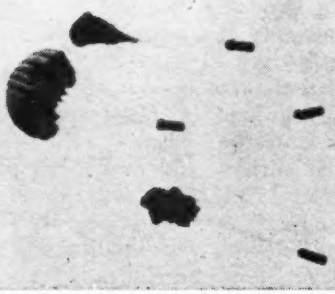

1. Pilot sets optimum height by turning knob on altitude-limit switch
2. Amber light indicates maintenance of correct height; red indicates too low; green too high.
3. Dial provides reading of height in feet.
G
A
R
RADIO ALTITUDE
ON

FIGURE 10

Flying Avengers turned suppliers, Air Delivery worked from both flat-tops and strips to 'chute emergency ammo, water, rations, and equipment to up-front infantrymen on Okinawa. In fact, at hundreds of key Pacific points, para-provisioning bolstered the battle—and bolstered the morale, too, with smokes and the like.... A combat correspondent's revealing story of how —

PARAPACKS KEPT 'EM PUNCHING



Four away! Down from Avenger—"infantryman's angel" —drop parapacks of food, water, and ammunition for Marines assaulting Shuri Castle on Okinawa. Air Delivery filled supply breach when incessant rains made roads impassable. (U. S. Marine Corps photos.)

By TECHNICAL SERGEANT DAVID STICK,
Marine Corps Combat Correspondent

A MARINE PATROL, up beyond the front lines near Shuri Castle on Okinawa, was dangerously low on rifle ammunition, and with water and rations long since exhausted, the men were getting hungrier and thirstier with each passing hour. They needed supplies—in a hurry.

The lieutenant turned to a field communications man.

"Try to get Air Delivery," was his order.

Half an hour later a Grumman-designed TBM Avenger torpedo bomber of Maj. Gen. Louis E. Woods' Second Marine Air Wing dipped in low above Shuri and passed directly over the advance patrol. A big pack that looked like an oversize sausage slid away from the underside of the plane. Then four more packs followed, parachutes billowing out above them all. All five landed less than 50 yd. from the patrol.

Exactly 32 min. after he put in his call for supplies the lieutenant had his rifle ammunition and his men were breaking open water cans and ration boxes.

That's the Air Delivery Section's job —to get needed supplies to isolated units in a hurry.

In one day, Marine and Army troops on the Okinawa battlefront received more than 30 tons of supplies in this manner. On the average, some 40 planes flew parapack missions over the front lines each day during the height of the Shuri and Naha battles.

Dropping supplies by parachute in the Ryukyus began during the first week of the Okinawa operation. Carrier-based Avengers, flying from as many as six different flat-tops in a single day, handled the job in the early phases of the campaign. Then the miracle-working Seabees and the Army engineers went to work on Yontan and Kadena airfields, and land-based Avengers of the Second Wing pitched in to help the carrier boys. As this was written, the two were working together frequently from early dawn until the sun set over the East China Sea, to keep the ground troops supplied with the necessities of war.

A Second Wing squadron commanded by Maj. Alan Feldmeier, of Little Falls, N. Y., flew more than 200 of these missions in a single week. One Army unit reported that 93 of 95 parapacks dropped to them by Maj. Feldmeier's pilots were recovered by the infantrymen.

It has been definitely determined, however, that the two they missed were not dropped by 1st Lt. Robert R. Piper, of West Alexandria, Ohio. Lt. Piper figured that the men sloshing around down there in the mud could stand a bit of liquid refreshment, so he dropped a quart of whiskey in each of his three ration parapacks. After discovering what was in the first one, the men ran out and caught the other two before they even hit the ground.

"There were so many men crowded around that I couldn't even see the parachutes," said Lt. Piper.

Ordinarily the target area is about 200 ft. square, and in order to drop the chutes right on the button the planes usually come in at an altitude of about 300 ft. Sometimes, however, the target area is smaller—a pocket held by our patrols, the side of a hill, or a small dip in a valley. At such times a cross is marked on the ground and the pilot tries to hit as close to the center as possible.

Here grateful Marines round up packs seen dropping in picture on opposite page.

On one early June morning, 1st Lt. Nestor C. Hardin, Jr., of Philippi, W. Va., was aiming at one of the cross targets. He dropped his pack directly above the target, but the chute failed to open—one of the few times that this has happened. Nevertheless, there was quick evidence of the precision of his aim. For the pack, unhindered by the parachute, scored a direct hit on the center of the cross.

For these parachute drops, the pilots must get special briefing on the nature of the target. The wind, too, comes in for more consideration when you're dropping light slow-falling parapack than when you're tossing bombs or torpedoes.

But just as important as the part played by the pilots is the work of packing the supplies in the containers and loading the packs in the planes. This was handled on Okinawa by a small detachment of Third Amphibious Corps Marines commanded by 1st Lt. Richard W. Sinclair, of Northampton, Mass.

Lt. Sinclair, like most of the men in his unit, is a former paramarine. A veteran of 12 yr. service as a Leatherneck, this tall, wiry lieutenant was a buck sergeant and the senior noncommissioned officer in the first group of Marines selected for paratroop training at Lakehurst, N. J., in 1940. He remained with the paramarines until that branch of the service was discontinued in 1943, serving first as an instructor and later as an air delivery man. His air delivery job with the paramarines was to drop guns and other equipment along with the airborne troops.

"That was simple in comparison with our job later," he says. "Frequently we had to work around the clock, taking care of rush orders. Most of the requests came in during the night, anyway, and that meant we had to get the planes loaded and off the deck at the crack of dawn."

Okinawan mud had a lot to do with complicating the job during the first few weeks in the Ryukyus, and the Jap bombers also managed to get in their licks at fouling up the works.

"In a single night," says Lt. Sinclair, "the Jap bombers made a clean sweep of my outfit. First they dropped a string of bombs in the ammo dump. A couple of minutes later, while my men were getting the fires under control, another Nip plane came in and hit the parachute loft. And just to round out the job, a third plane dropped a couple of big ones in the bivouac area." But next morning the parapack planes took off despite all this—and on schedule.

The lieutenant's outfit has handled air deliveries on ten Marine operations in the south and central Pacific. They started out at Vella Lavella, Choiseul and Bougainville in the Solomons, at New Georgia, where they supplied the old Marine Raiders and at Cape Gloucester. They also dropped stuff to the New Zealanders landing on Green Island, and to our own troops going in on Emirau in the St. Mathias Islands.

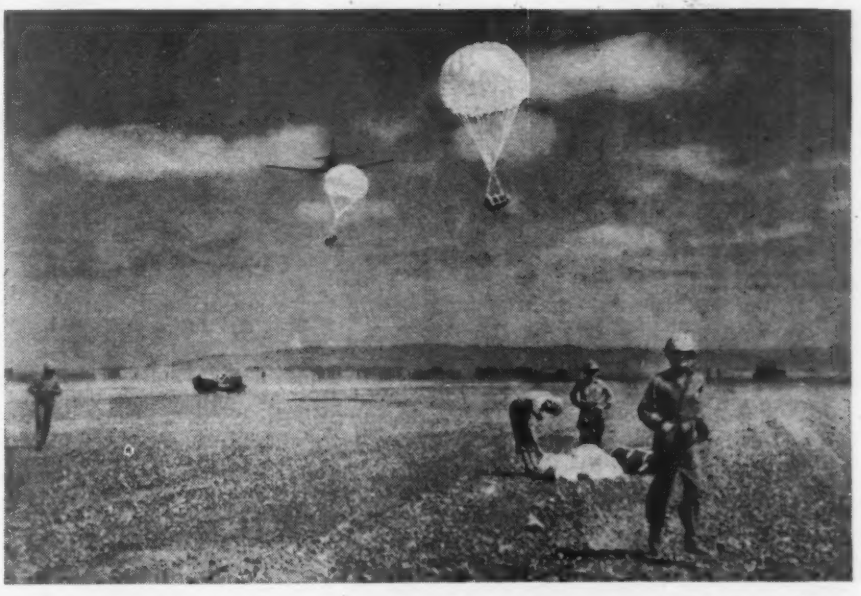
On Christmas Day of 1943, from a plane which used "Santa Claus" as its radio call name, they dropped 500 turkeys and 240 cases of beer to members of a New Zealand brigade on Choiseul. It was their outfit, too, that dropped supplies every four days to those famous Fiji Scouts operating as guerrillas behind the Japanese lines on Bougainville.

When our troops landed in the Marianas Lt. Sinclair's air delivery boys went along, and their supply planes were among the first to operate from newly captured air bases on Saipan. They moved down the line, to Tinian and then to Guam, and on Apr. 1, 1945, L-Day for Okinawa, small units of his detachment were back on the job on each of 15 different aircraft carriers.

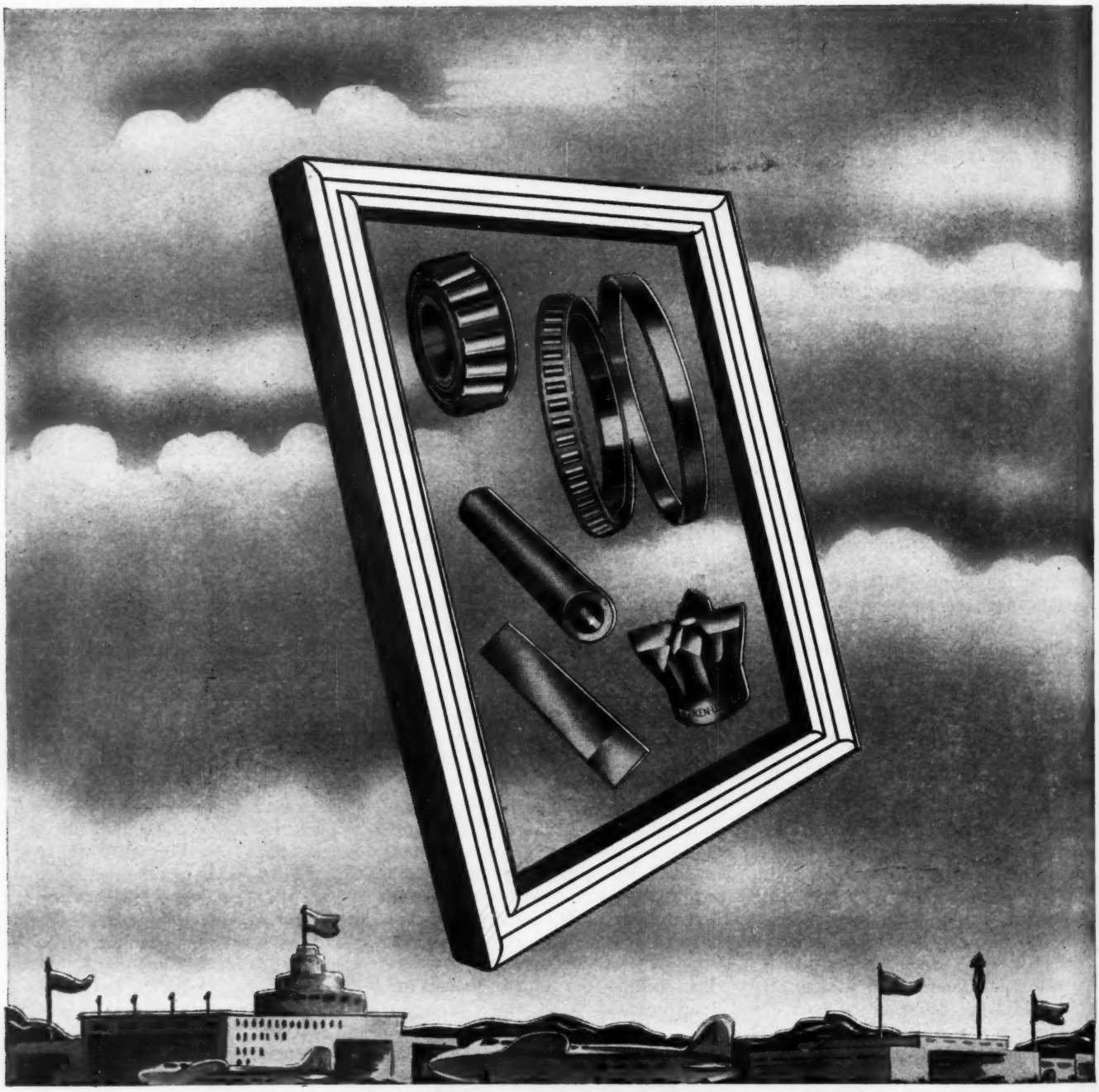
The lieutenant, it might be added, dropped in weight from 175 to 130 lb. in two months on Okinawa.

He wasn't particular about the kind of plane he used for parapack drops, and since no craft were regularly assigned to his outfit it was often a matter of using whatever planes could be borrowed. On Okinawa, Second Wing Avengers, for example, slipped frequent parapack missions between bombing and strafing runs against Jap

(*Turn to page* 242)



Leathernecks on Iwo Jima gather packs of mail air-delivered from transport aircraft during course of Island campaign. Quantities of essential blood plasma also were 'chuted down to troops.



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Design Analysis of the FAIRCHILD C-82 PACKET

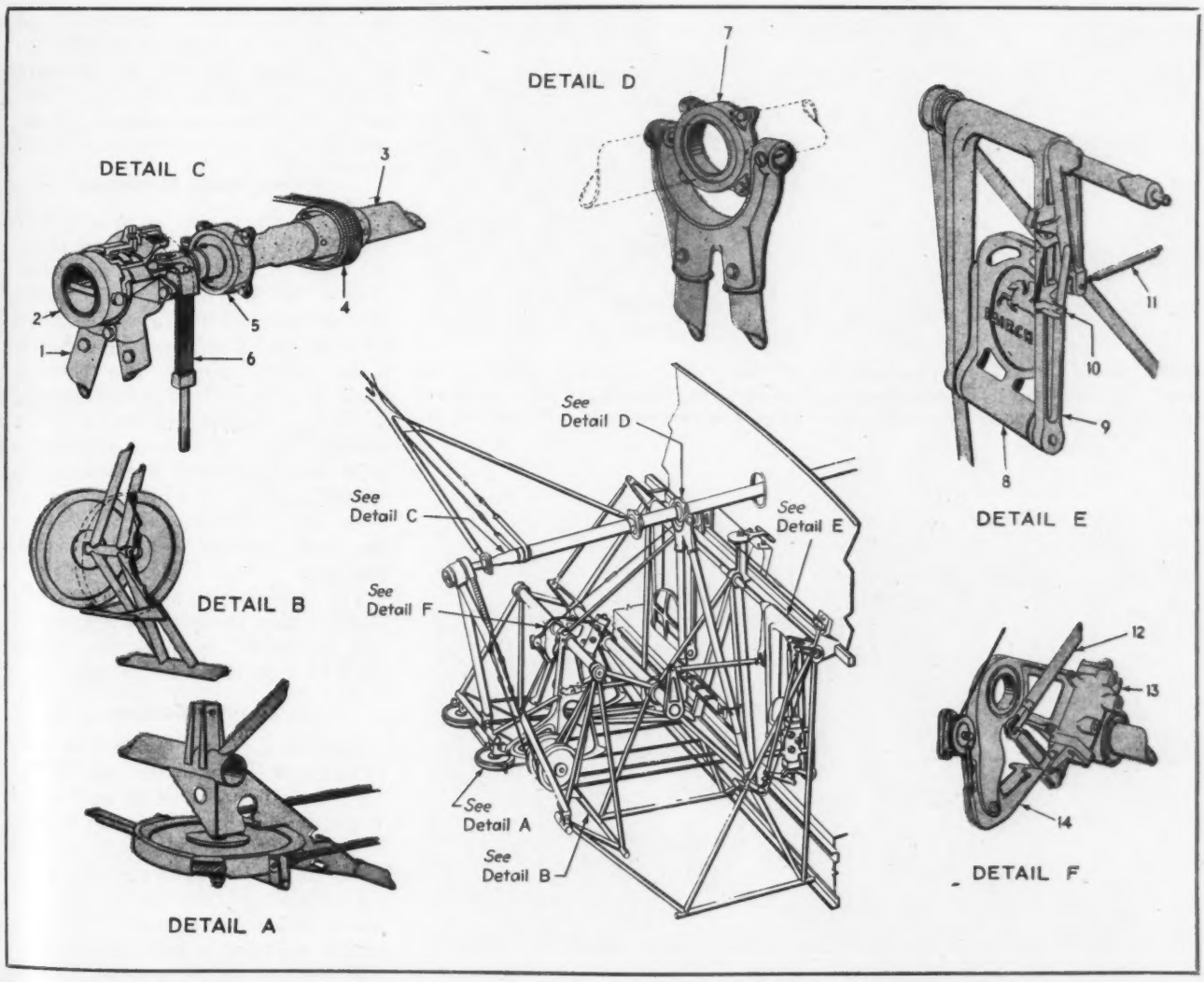
PART II

By **IRVING STONE**, *Assistant Editor, "Aviation"*

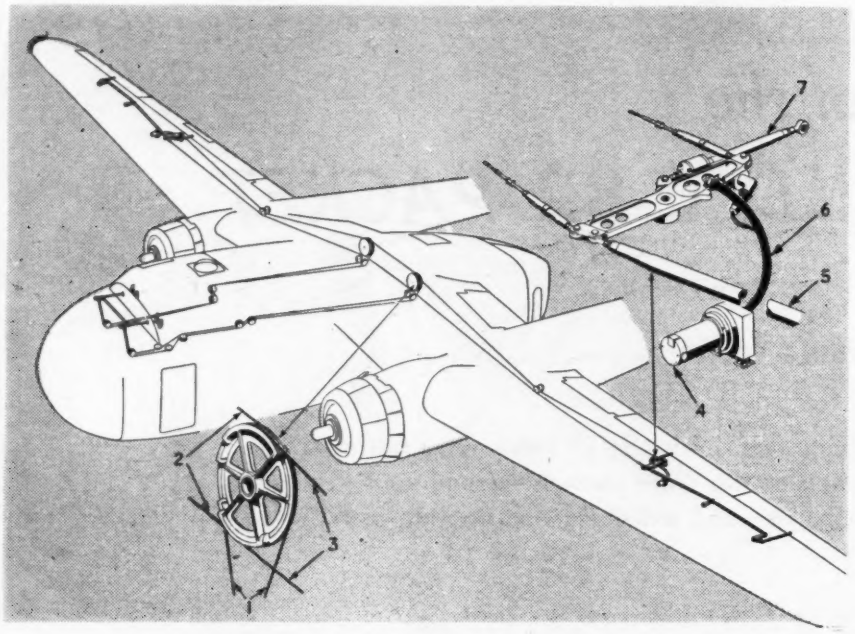
Concluding the comprehensive study of this unique cargo craft, details are presented of the flight control system, landing gear, power plants, equipment, and anti-icing and heating provisions.

THE PACKET'S flight control system is a duplicate and dual installation consisting of cable sectors, pulleys, bellcranks, and push-pull rods. It is duplicate because there are two complete and independent systems —one on each side of the plane—and dual because, through a series of interconnections, either system may be operated from pilot's or co-pilot's station in event of failure of any part of either system.

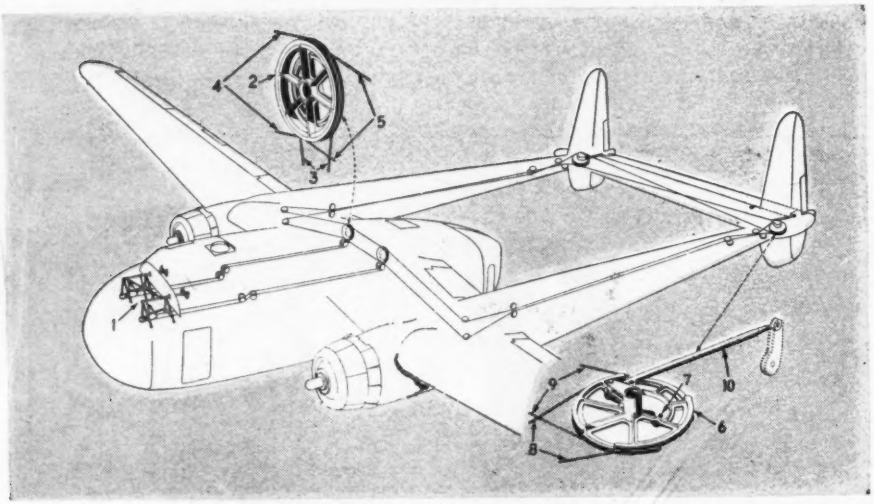
The two control wheels in the cockpit operate a set of differential ailerons. Each wheel is splined to one end of a



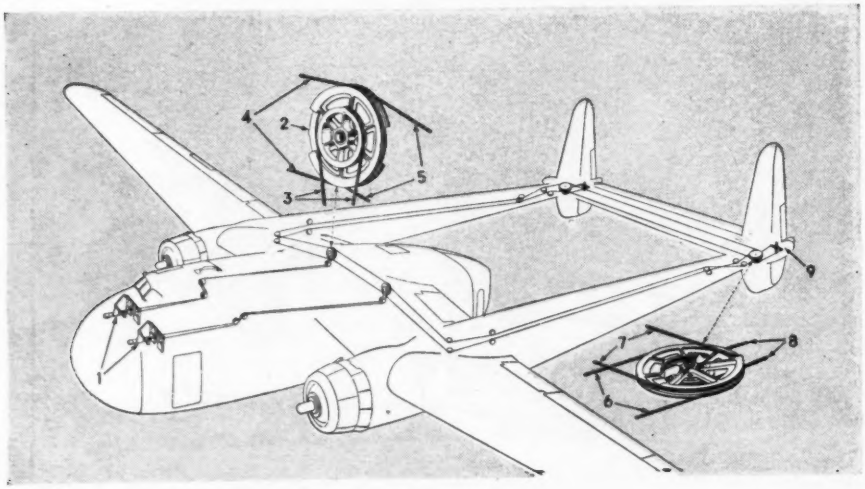
Surface control truss installation in pilots' compartment. Explanation of details: (A) Elevator pulley; (B) aileron pulleys; (C) — (1) truss forward legs, (2) aileron stop mechanism, (3) control column, (4) aileron motion column interconnect, (5) elevator motion column interconnect, (6) aileron cable actuating chain; (D) — (7) control column trunnion; (E) — (8) rudder pedal, (9) pedal arms, (10) leg adjustment, (11) actuating push-pull for rudder sector; and (F) — (12) push-pull for brake valve, (13) valve, and (14) parking latch.



Aileron control system including droop mechanism: (1) Cable to cockpit, (2) interconnect and to servo, (3) to surface, (4) droop actuating motor — synchronized with flap for landing, (5) push-pull connection between inboard and outboard aileron, (6) flexible shaft, and (7) screwjack actuator.



Elevator control system: (1) Interconnect truss, (2) sector wheel at rear spar, (3) cable to cockpit, (4) to surface, (5) interconnect and to servo, (6) sector for surface movement and interconnect, (7) stop, (8) to rear spar sector, (9) interconnect, and (10) push-pull to surface horn.



Rudder control system: (1) Actuating sectors in cockpit, (2) sector on rear spar, (3) cable to cockpit, (4) to surface, (5) interconnect, (6) to rear spar sector, (7) interconnect, (8) to horn, and (9) location of stop.

torque shaft and the two shafts are interconnected by a chain and cable hookup. A chain, at the end of which two cables are attached, engages a sprocket mounted in bearings housed in the forward torque tube support and connected to the torque tube by a universal joint. The two cables run down and aft over a series of guide pulleys to a triple-grooved sector located just aft of the center section rear spar. Another cable engages this sector and is led behind the rear spar over guide pulleys to a horizontally mounted differential bellcrank located halfway along the inboard aileron. A push-pull rod bolted to the forward arm of the bellcrank, extends to an idler lever from which another push-pull rod operates the outboard aileron differential bellcrank. Between the outboard aileron horn and the differential bellcrank, the aileron operating rod is installed.

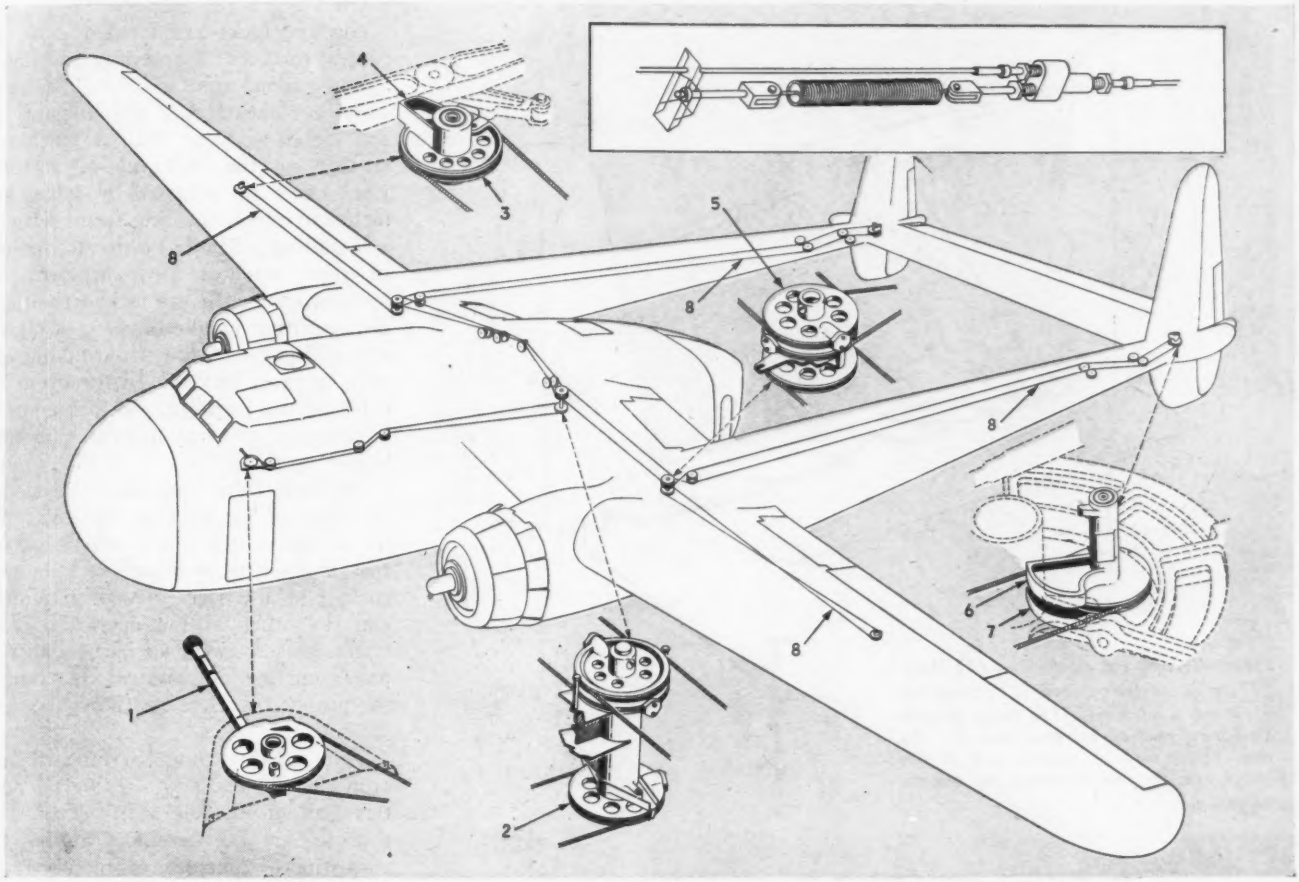
Aileron Droop Mechanism

Inboard ailerons, in addition to their normal functions, are also used to assist flaps in landing. This is accomplished by inserting an electrically operated screw actuator unit between the differential bellcrank and the inboard aileron horn. The actuator motor is operated by a switch mounted on the flap operating mechanism which actuates the switch upon reaching a point corresponding to just beyond flap takeoff position. The two aileron actuators are electrically synchronized so that both ailerons will drop simultaneously.

The linkage is so arranged that the control wheel moves 150 deg. either side of neutral to move the aileron from 12 deg. down to 24 deg. up.

Elevator Control

Elevator control is obtained by fore-and-aft movement of the control column, pivotally mounted on an inverted V-truss in the front end and an A-truss in the rear. The column is fastened to the forward truss through the housing which holds the aileron sprocket, and is fastened to the rear truss by a gimbal engaging a ball bearing trunnion mounted on the column. The two control columns are interconnected by a K-truss bolted to two trunnions on each column.



Surface control lock system: (1) Locking arm extending across pilot's seat (locked position), (2) tie-in sector to locking arm, (3) aileron cam lock, (4) cam edge, (5) intermediate sectors, (6) elevator cam edge, and (7) rudder cam edge. Inset shows emergency release for cam to hold it in open position if control cable is shot away or breaks in flight. Unit locations are seen at (8) in main sketch.

To the cross bar of the A-truss is bolted a push-pull rod operating a vertically mounted sector. To the sector is fixed one cable of a continuous cable system which runs aft over a series of guide pulleys to a triple-grooved sector located aft of the center section rear spar. Two other cables are fixed to this latter sector—an interconnecting cable running crosswise to a similiar symmetrically located sector in the duplicate elevator system, and another cable which runs along the rear spar over a series of guide pulleys to the nacelle and through the boom to a horizontally mounted sector in the aft boom. On the aft boom sector is an integral arm which operates the elevator push-pull operating rod. An interconnecting cable anchored to the sector passes through the stabilizer to engage a similar sector of the duplicate system installed in the opposite aft boom.

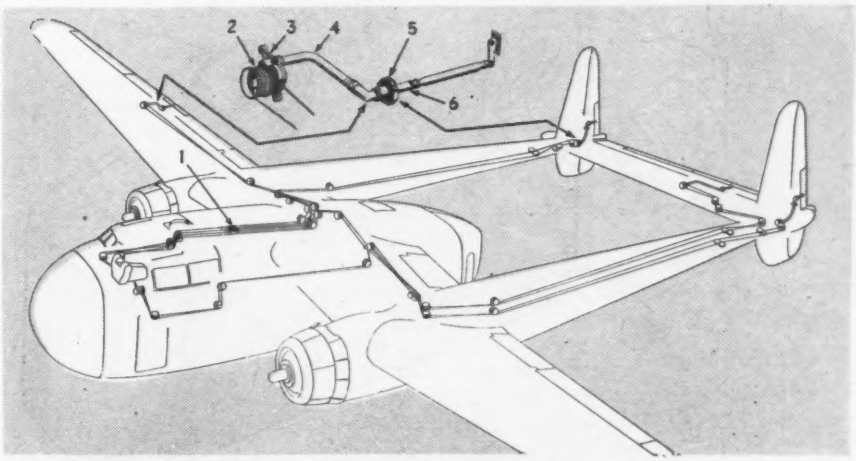
The control column moves a total of 18 in. to move the elevator from 25 deg. down to 35 deg. up.

Rudder Control

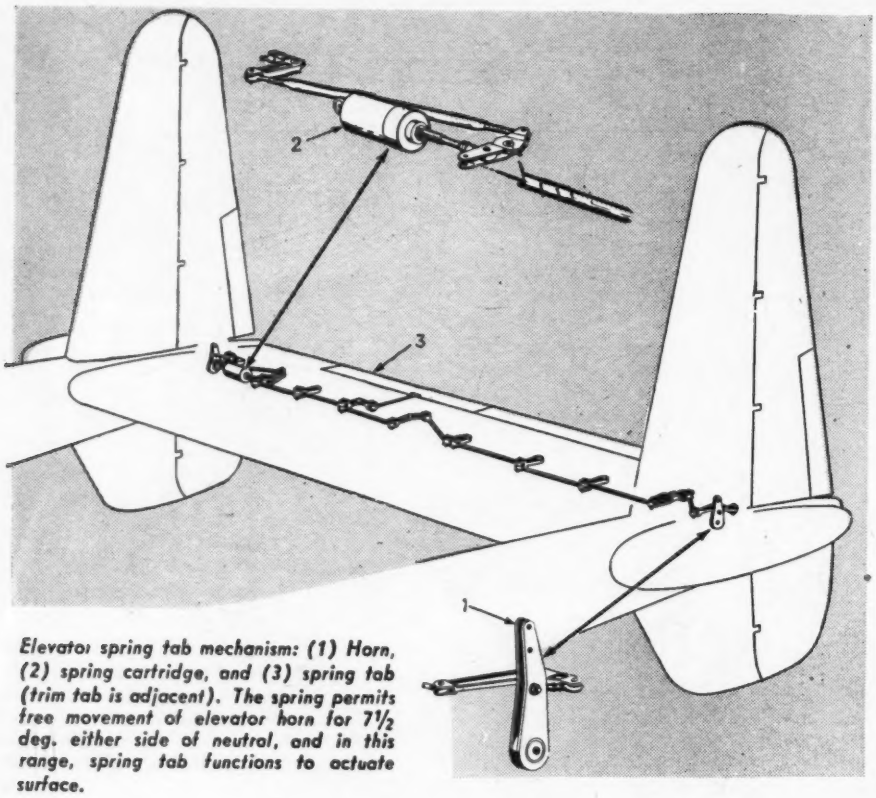
Rudders are controlled by movement of a pair of top-hung type pedals adjusted for long and short leg positions by a pawl connecting the pedal to a ratchet on the actuating arm. Through a push-pull rod, the actuating arm imparts movement to an arm bolted to a horizontally mounted torque shaft carrying the rudder sectors and pedal interconnecting arm. A push-pull rod connects the other pedal to this arm to cause each pedal to move in the opposite direction.

The cable system—similar to that for the elevator—transmits pedal movement to an interconnecting sector at the rear spar and then to the sector at the aft boom where the two systems are again interconnected. From the latter sector, cables pick up a set of rudder horns mounted on a torque tube by which both the upper and lower rudders are actuated.

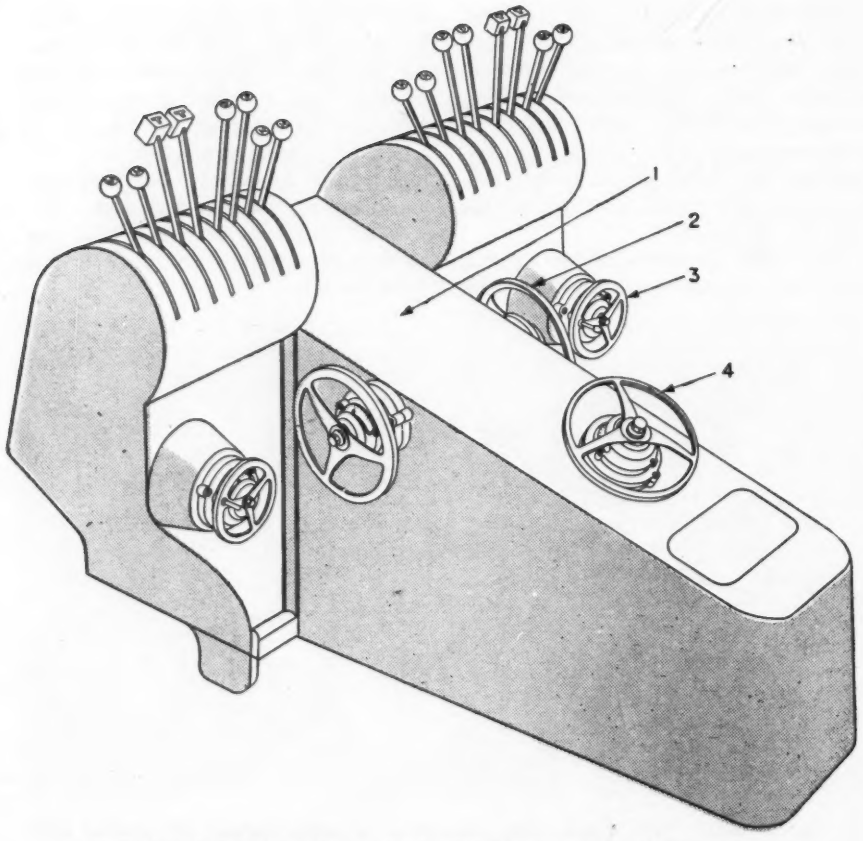
With pedal movement of 22 deg. rudders correspondingly move 35 deg. right or left.



Tab control system: (1) Tandem cable connections in rudder system, (2) grooved cable drum, (3) gear box, (4) flexible shaft, (5) tab screwjack mechanism and mount, and (6) irreversible screwjack.



Elevator spring tab mechanism: (1) Horn, (2) spring cartridge, and (3) spring tab (trim tab is adjacent). The spring permits free movement of elevator horn for 7½ deg. either side of neutral, and in this range, spring tab functions to actuate surface.



Control pedestal for engines and tabs: (1) Location of electrical switches, (2) elevator tab wheel, (3) aileron wheel, and (4) rudder wheel.

Surface locks are located close to control surfaces to protect against damage by ground gust. Each lock is, basically, a rotating cam which mates in the locked position with a machined surface on the bellcrank or sectors. Lock cams are actuated by cables attached to interconnecting sector wheels, and pulling a handle located to the left of pilot actuates all lock cams simultaneously. In the locked position, the operating handle lies across pilot's seat and prevents him from taking off with surfaces locked. In the event of cable failure in flight, the lock control is designed to keep the cams in unlocked position.

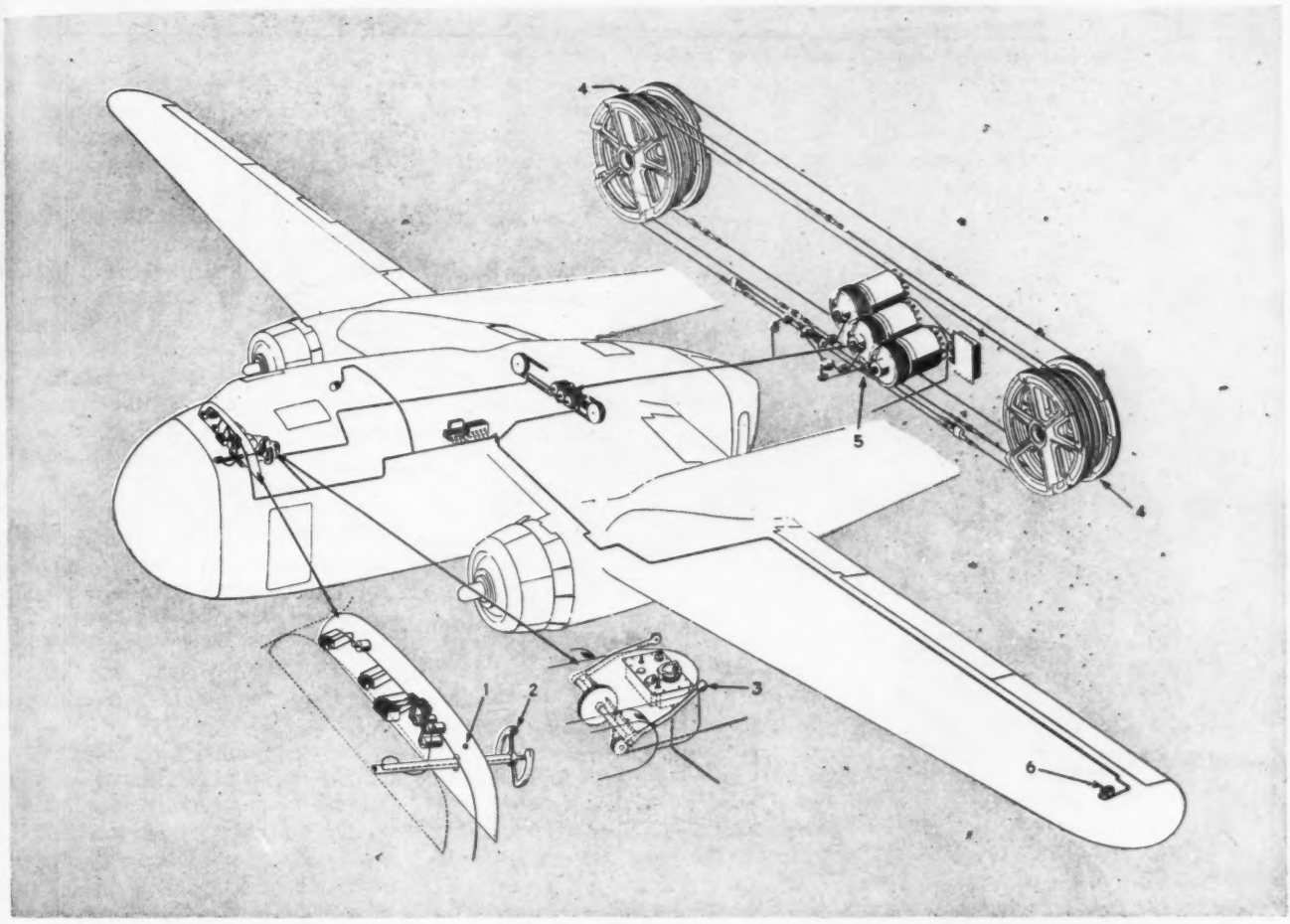
To avoid subjecting control systems to overload by pilot or by gusts on the surfaces, two sets of surface control stops are installed—one in the cockpit at the steel structural mount and the other at the operating bellcranks closest to the surface—with the provision for adjustment to assure the proper travel of the movable surfaces.

Trim tabs are used on inboard aileron and rudders, and a spring tab and trim tab on the elevator. Trim tab controls are conventional in design, consisting of control units mounted accessible to pilots, cable drums, pulleys, cable, and irreversible screwjacks at the tabs. Tab control units incorporate dials and stops and allow for a small amount of overtravel.

Elevator tab to the left of the centerline is a trim tab, and the one on the right is a spring tab. Spring tab action is accomplished by holding the elevator horn in neutral, balanced against a 142-lb. compression spring (mounted within the elevator) to permit 7½ deg. of horn motion either side of neutral in relation to the elevator. Horn motion is transferred by push-pull rods and levers to produce 30 deg. up or down movement of the tab in the direction desired to aid the movement of the elevator.

A rigid push-pull rod and bellcrank system operates the four flaps. A motor-operated screwjack and nut actuator is located in the fuselage center rear upper section. Rotation of the screw causes the double-lugged nut to move fore-and-aft on the screw, and to each lug is bolted a horizontally mounted bellcrank pivoted between two V-braces, one on top and one on the bottom. Free ends of the V-braces are bolted to the housing mounting the screw and motor, while the apexes of the braces support the bellcrank.

To the other arm of the bellcrank is bolted a push-pull rod which runs outboard to the inboard flap operating bellcrank. Another push-pull rod connects a similar operating bellcrank at



A-10 automatic pilot installation: (1) Location of automatic flight controller, (2) electrical disengaging switch, (3) mechanical emergency disconnect, (4) sector wheels for aileron, elevator, and rudder systems, (5) servo units, and (6) Gyro Flux Gate transmitter.

the outer end of the inboard flap—there being two operating points on each flap. Other push-pull rods extend outboard to pick up the two outer flap operating bellcranks. Each bellcrank operates a push-pull rod connected to a vertically mounted beam. Upper end of the beam is hinged to the wing structure and lower end is hinged to the operating point on the flap leading edge. A three-position switch located on the control pedestal is operated to lower the flaps.

An A-10 electrically powered automatic pilot is used in the Packet and consists of a Gyro Flux Gate transmitter, Flux Gate amplifier, master direction-indicator, servo amplifier, three servo motors, Gyro-Horizon indicator, bank-and-turn indicator, controller unit, clutch switch, and an emergency manual servo disconnect control.

The Gyro-Flux Gate compass system—from which the directional signal is derived—includes a transmitter, amplifier, and master direction-indicator and two repeater indicators. The Flux Gate transmitter is located on the tip of the left wing outer panel, and the amplifier on the left side vertical bulkhead in the front section of the fuselage. The master direction-indicator is mounted on the instrument board in front of the pilot and with the bank-and-turn and Gyro-Horizon control, forms part of the pilot's flight control instruments.

The controller, mounted on the fixed portion of the instrument board directly in front of pilot, enables him to climb, dive, or make correctly co-ordinated turns by means of the automatic pilot.

The Gyro Flux Gate transmitter and amplifier and the three flight indicators are directly connected to the electrical power bus and to the inverter. These instruments are used by the pilot during manual and automatic flight. Electrical power is supplied to the servo amplifier through a control switch located on the forward overhead control panel. A push button solenoid switch located adjacent to the control switch engages or disengages the servo motors. The servo motors may also be disengaged electrically by push-button switches, one located on each control wheel.

The servos are rigidly mounted aft of the center section rear spar. They are staggered in the fore-and-aft direction to place the three servo pulleys in line with the interconnecting cables of aileron, elevator, and rudder control systems. The interconnecting cable which wraps around the servo pulley, links the automatic pilot directly into each system when the clutch switch is placed in engaged position. With the automatic pilot clutch disconnected, the servo units rotate freely, permitting manual control of the surface.

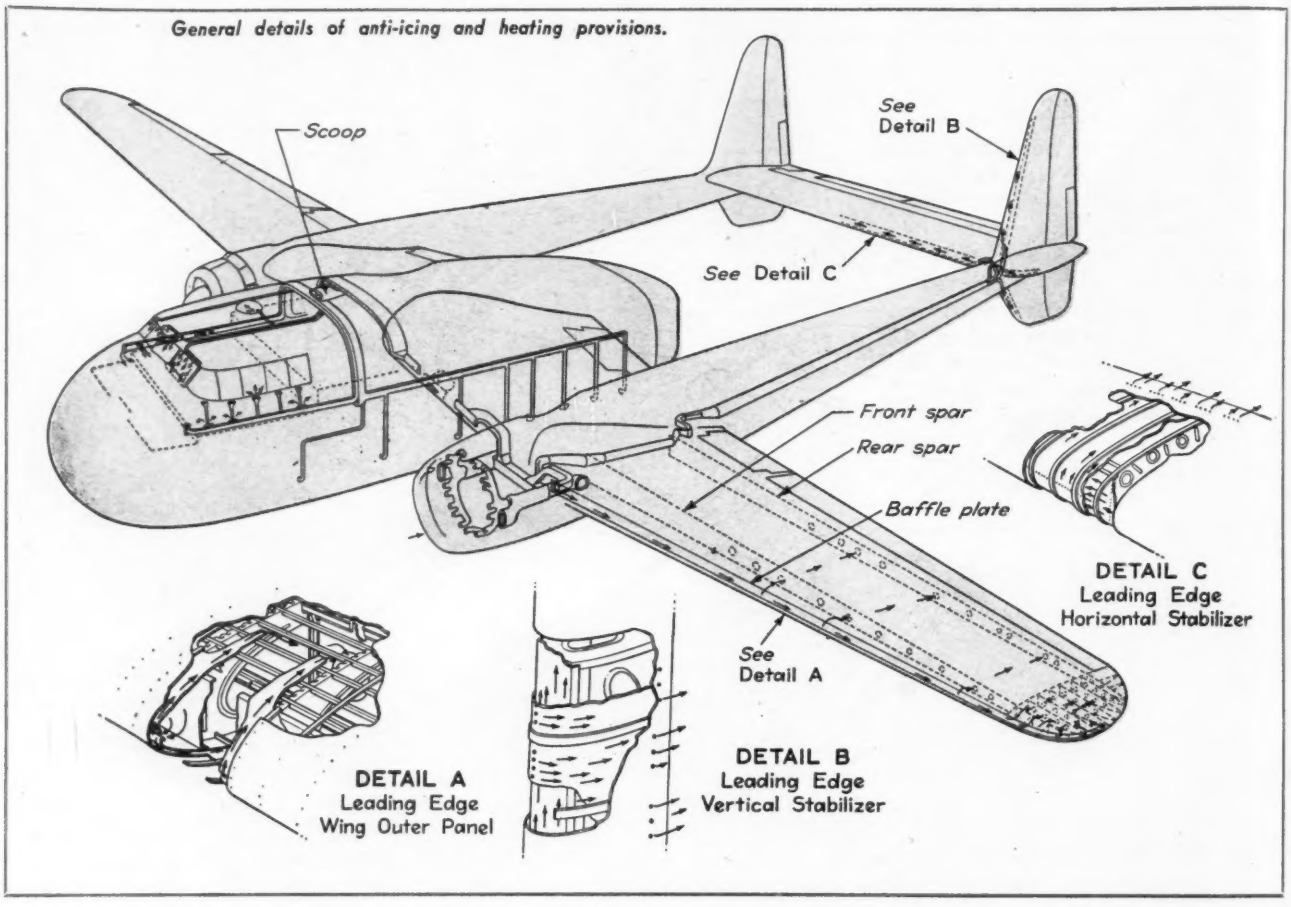
In event of failure of the servo units, the drums may be disconnected manually and simultaneously by pulling up on the servo emergency disconnect lever mounted on the control pedestal. A cable system connects the lever to the clutch disconnects on the servo.

Anti-Icing, Heating, and Ventilating

The anti-icing system protects all flight surfaces and air intake scoops (carburetor, oil cooler, heating and ventilating, and anti-icing).

Heat for the system is obtained by passing ram air, from a scoop on the lower portion of each primary cowl, through four crossflow type heat exchangers located in the exhaust systems between collector rings and exhaust stacks.

Exchangers are connected by a trunk duct extending across the wing center section and fuselage, thus permitting functioning of the entire system even though one engine is inoperative. From this duct, another leads to



the outer wing leading edge duct extending the entire length of the outer panel and tip. After passing through the leading edge duct, the air dumps into the inner portion of the wing and exits on leading edge of ailerons. Center wing section anti-icing is accomplished similarly.

From a main trunk within each boom, a duct leads to the empennage, and smaller ducts lead to stabilizer tip, and upper and lower fins. Heating of these surfaces is accomplished similarly to the outer wing panel except that the air exits onto upper and lower outside surfaces through a series of small holes.

Windshield anti-icing is by hot air from main trunk cross-duct, and after dispersal between the double glass panels, the air is dumped outside of fuselage below the windshield.

The system for crew and cargo compartments secures heated air from the main trunk duct across fuselage, supplied from the two inboard heat exchangers. The heated air, passed through a secondary heat exchanger in fuselage, to insure freedom from carbon monoxide, is diverted through ducts to the cargo compartment, and is circulated from 16 anemostat units located along each side of fuselage, approximately 1 ft. above the floor. Air for cockpit is secured via a scoop on top of cockpit and is also heated by passing through the secondary heat exchanger, then being distributed through ducts to anemostat units on each side of cockpit. Other ducts bring in air for defogging windows and avigation dome.

Ventilation is accomplished by introducing to the heating system, variable amounts of cold outside air, with proportion controlled by crew.

Anti-icing and heating and ventilating systems are electrically controlled from the switch panel above and between pilot and co-pilot. Two switches permits selection of heat from all four heat exchangers for anti-icing; from all four exchangers for anti-icing and fuselage heating; from two inboard heat exchangers for fuselage heating; and from the heat exchangers at either engine for any of these purposes.

Two manual push-pull controls to valves in the cockpit ducts control temperature of crew and cargo compartment, and temperature can also be adjusted from crew chief's station in cargo area. Electrically operated valves at each heat exchanger permit dumping of hot air overboard, and similar valves are located in each duct leading to anti-icing areas and fuselage heating duct.

For prevention of fire, asphyxiation, and damage to structures because of excessive heat, thermostats controlling each dump valve are located at each heat exchanger and in wing internal area. A carbon monoxide indicator is located in the fuselage. Warning lights on the control switch panel indicate the position of the dump valves and the presence of carbon monoxide.

Nose Gear

The Packet is equipped with fully retractable landing gear consisting of non-steerable nose gear, main landing gear, emergency gravity extension system, door-operating mechanism, and warning and indicating system.

No appreciable movement of the center of gravity of the airplane is encountered (less than one percent) as the landing gear units move from fully extended to fully retracted positions.

Nose gear consists of an Aerol shock strut, single side strut and axle unit, hydraulic shimmy damper, 44-in. smooth contour tire mounted on magnesium wheel, upper truss, lower truss, retracting unit, and two retracting links.

The nose wheel shock strut has a self centering device which forces the wheel in a fore-and-aft direction as load is removed. At upper end of the strut a fitting is provided for attachment to the upper truss. At lower end are two cantilever arms for attachment of lower structure. Provisions are made at lower end of the piston for bolting the side strut and axle unit, and

to the cylinder is bolted the shimmy damper.

Upper truss is V-shaped, and tubular units are equipped with double-lug forged fitting at the apex and two single-lug forged fittings at the free ends. Double-lug fittings are welded at midpoint of tubes for bolting a forged steel beam that holds the retracting links.

Lower truss consists of two outer tubes and an X-brace. At both ends of outer tubes, fittings are welded to form the upper and lower joints and also to provide lugs for bolting the X-brace.

Retracting mechanism consists of ball bearing screw-and-nut actuator, side mounting frames, double sprocket and chain train, torque shaft, and two retracting arms. The screw-and-nut actuator converts rotational motion at high speed to linear motion at low speed. A motor drives a planetary reduction gear train which turns the screw to cause linear movement of the nut.

A solenoid clutch is incorporated to instantly engage the motor with the gear train upon application of current, or to disengage it when current is shut off. The clutch has a brake which automatically retards the gear train when clutch is disengaged, to prevent the landing gear from continuing to move when the current is discontinued by pilot or limit switches.

The nut is gimballed to driving arms on two upper sprockets keyed to a spindle with ends supported in ball bearing housings in the center of the side frames. Upper ends of the side frames are bolted to supporting fittings on the forward part of the fuselage, while the lower ends support a torque shaft on which are mounted two sprockets and two retracting arms. Lower sprockets are located in the plane of the upper sprockets and retracting arms are in the plane of the retracting link. The torque shaft is supported at its ends by bearings located in fittings at the vertical fore-and-aft fuselage beams, and in turn supports the lower truss and a brace strut which ties the upper truss upper support fittings and the lower truss upper support.

Kinematic linkage of the nose gear —a parallelogram in form, with sides consisting of shock-strut, upper truss, lower truss, and brace strut—permits the wheel and shock strut to move vertically during retraction. Retraction is accomplished by movement of the nut which causes rotation of the upper sprockets, whose motion is transmitted through chains to the lower sprockets to turn the torque shaft and retracting arms. The latter push the retracting links, and cause the upper truss to rotate about its upper supports, thus lifting the shock strut and wheel into retracted position. Upward movement of shock strut rotates the lower truss about the torque shaft, which guides the motion of the shock strut.

For gravity extension of nose gear, the actuator is provided with a quick-release mechanism which disengages the screw from the gear train and allows the screw to rotate freely, the nut being forced down under the weight of the gear. To control the speed of drop, an energy-absorber unit is provided—basically a hydraulic actuator which dissipates energy by passing fluid from one side of the piston to the other, via an orifice. Fluting the inside of the lower end of cylinder increases the orifice area, and when the piston reaches these flutes, the increased area accelerates the flow of the fluid to speed the drop sufficiently to permit the down locks to snap in place.

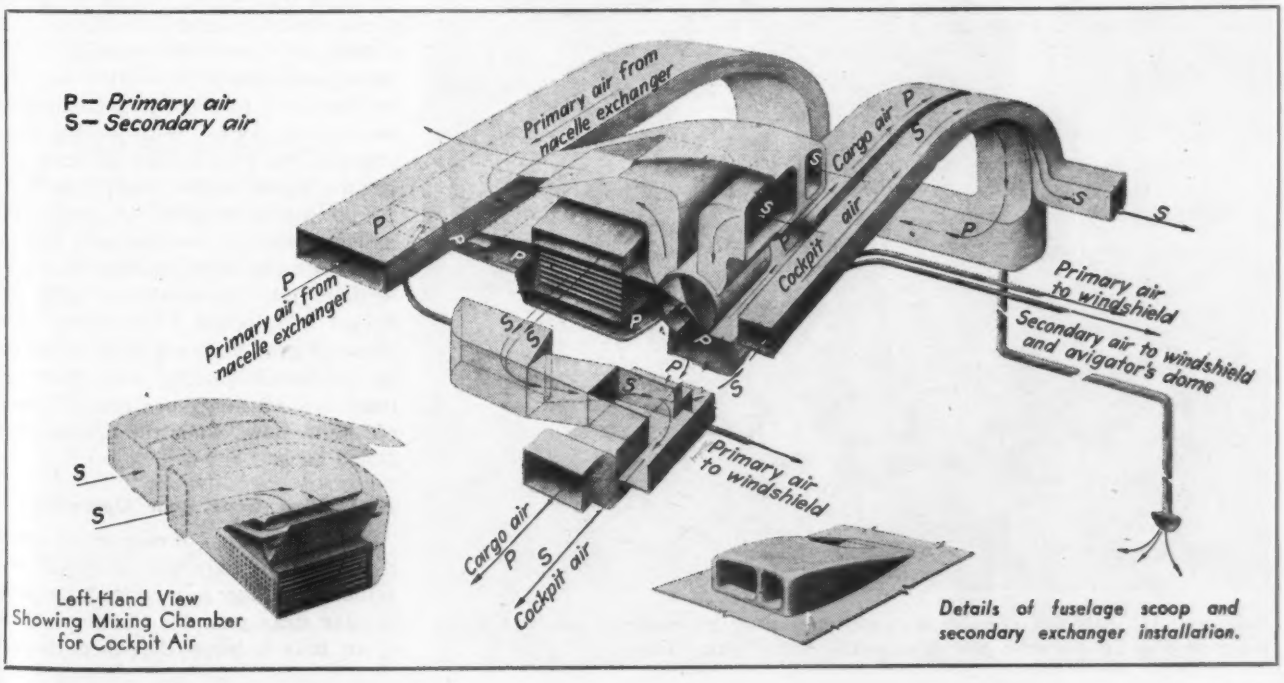
Main Landing Gear

Main landing gear—extending approximately 12½ ft. from upper support point to bottom of wheel—consists of two shock struts, upper and lower main trusses, upper and lower drag struts, interconnecting transverse beam, and horizontal link bar tying the main upper truss to the upper drag struts. One end of each retracting link is mounted on the bolt which fastens the horizontal link bar to the upper drag trusses, and the other end is bolted to two retracting arms fixed to a torque shaft which supports the retracting mechanism and its supporting side frames. Ends of the shaft are mounted in bearings housed in the nacelle steel structure.

Upper main truss is made of two swaged tubes with forged hinge fittings welded to upper ends and forged knee fittings welded to lower ends.

Upper ends of an X-brace space the swaged tubes 43 in. at top, while lower ends of brace and a spreader tube space the swaged tubes 30 in. at the bottom. Provision is also made on the swaged tubes for attaching the ends of the link bars.

The lower main truss has two swaged tubes with welded forged knee fittings at the top and opened at the bottom to receive the shock struts. Tubes are held 30 in. apart by an X-brace bolted to fittings on the side of the tubes.


P — Primary air
S — Secondary air
Primary air from nacelle exchanger
Cargo air
Cockpit air
Primary air to windshield
Secondary air to windshield and avigator's dome
Primary air from nacelle exchanger
Primary air to windshield
Cargo air
Cockpit air
Left-Hand View Showing Mixing Chamber for Cockpit Air
Details of fuselage scoop and secondary exchanger installation.

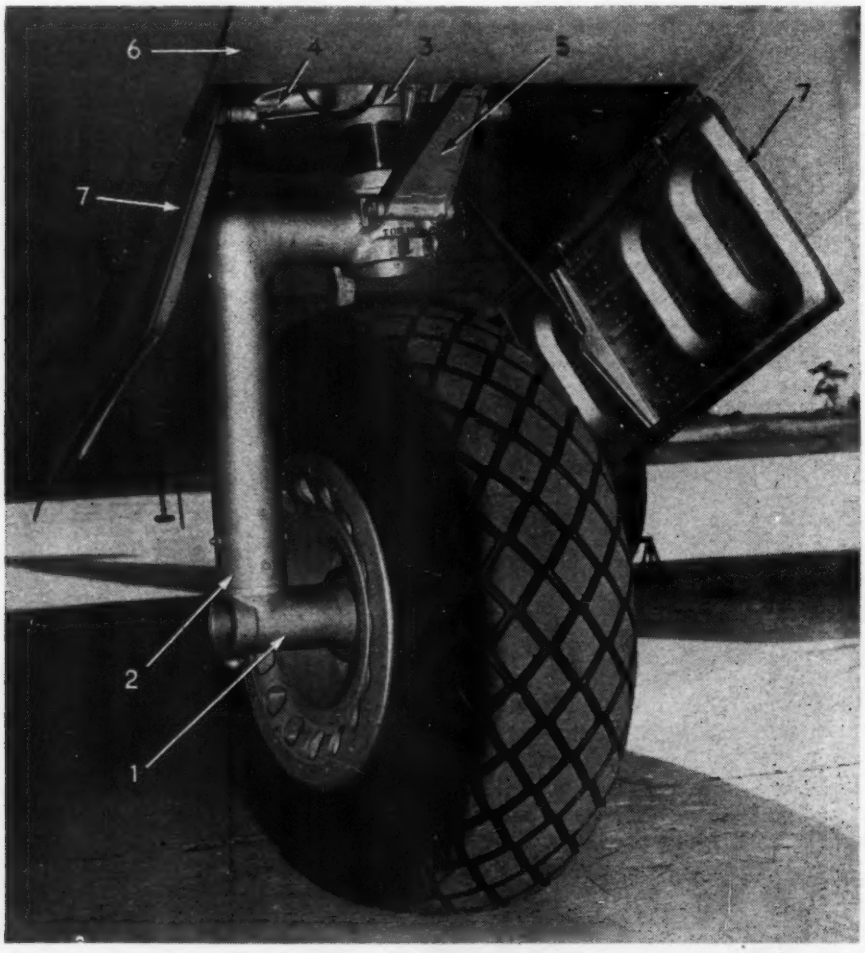
Upper drag struts—two king-post trusses with apex on the bottom—have fittings welded to the lower ends and the apex, to attach to the lower drag struts at the end, and to the retracting link and horizontal bar at the apex. The main tube is made to extend at the upper end to the transverse beam—an oval-shaped tube with tapered ends on which are welded two sockets for receiving the upper drag trusses, two hinge fittings for mounting the beam to nacelle structure, and two lug-type fittings for supporting the side frames of the retracting mechanism.

Lower drag struts are tubes with forged ends and separated by K-bracing to space them 30 in. apart.

On the cylinder fo each shock strut are welded two double-lugged fittings —one on top to receive lower drag strut, and one on bottom on which is bolted a jacking link. On the rear side, opposite these fittings, is welded a jacking fitting of AAF standard dimensions. A forging at the lower end of the piston straddles the axle, and is provided with two attaching bolts.

A small hook on the front face of the forging is used to engage the jacking link to facilitate servicing and installation of the wheel. When the jacking link (on the cylinder) is swung down over the hook (on the piston), the two attaching bolts are removed, and the plane is jacked at the jacking points on the cylinder. As the plane rises, the piston extends (because of the weight of the wheel) until the jacking link contacts the hook, and the piston then moves up with the cylinder and away from the axle to permit the 56-in. wheel to be rolled from under the shock strut fittings.

Retracting links and arms and retracting unit consisting of an actuator, chains, sprockets, and torque shaft, are similar to those used on the nose gear, but larger. Two energy-absorber units are used on each main gear and, except for length, are also similar to nose gear installation. During retraction, the retracting link forces the upper drag strut to rotate about the hinge points of the transverse beam, and the horizontal tie bar forces the upper main truss to rotate to the rear about the upper hinge fittings. Rotation of upper truss breaks the knee joint between upper and lower main truss and carries the upper end of the main lower truss to the rear and upward. At the same time, the rotation of the upper drag strut carries the lower drag strut and the lower end of the main lower truss upward.



Nose gear: (1) Axle unit, (2) side strut, (3) shock strut, (4) cantilever arm, (5) scissor, (6) front door (closed after gear is extended), and (7) rear doors.

Landing Gear Control

Landing gear is controlled from the cockpit by either pilot or co-pilot by a dual handle. Freed of the locating slot, the handle is pulled to a vertical position to retract the gear, thus turning a shaft on which are mounted two pulleys, and cables anchored to the pulleys actuate a series of levers and cams which cause the down locks to open, freeing the retracting arm, and permitting the torque shaft to be rotated.

On reaching the vertical position, the handle is pushed to the side into a positioning slot and actuates switches in the landing gear motor circuits to cause retraction of the gear. Retracting arm, on reaching the maximum position, trips a switch to stop the actuator motor.

To extend the gear, the operating handle is moved forward and down to the normal down position. Engagement in the position slot actuates a switch in the circuit and the gear moves to the extended position. As spring-loaded dogs engage the latches on the retracting arm, they actuate a switch which cuts off the current.

In the event of power failure, the gear may be extended by gravity by pushing the control lever forward and down, past the normal down position to emergency down position.

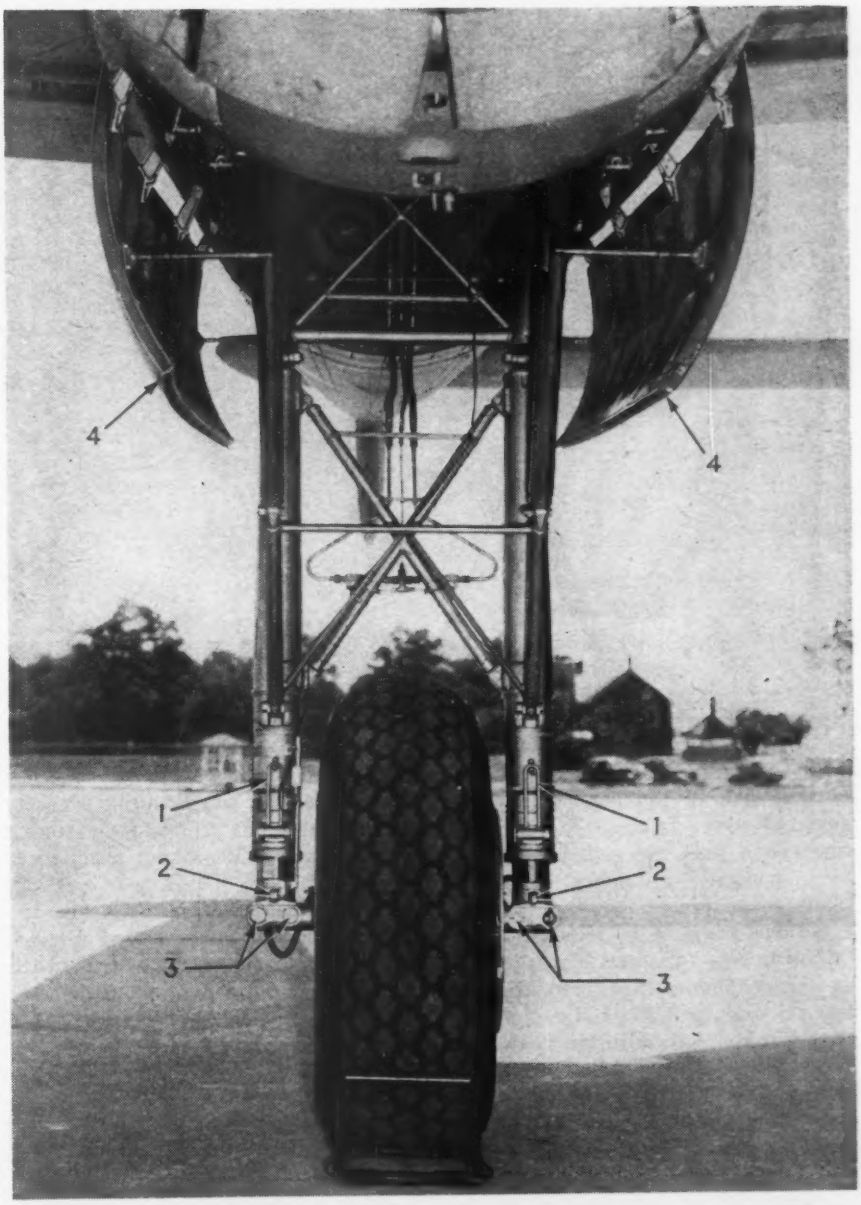
A safety switch, installed on each landing gear unit to prevent accidental retraction of the gear when the airplane is on the ground, closes the motor circuit only when the oleo struts are extended—as in takeoff, with load removed from strut. As an additional precaution, a ground lock consisting of a steel pin (with a red streamer for visual attraction) is inserted into the locking links to prevent unlatching of the locking dogs. With locking dogs engaged, the gear cannot be retracted.

Two lights in the cockpit indicate the position of the gear. A green light indicates that it is down and locked, whereas a red light indicates that it is neither fully retracted nor fully extended and locked. No lights show when all gear units are fully retracted, but to avoid landing with gear retracted, a warning horn sounds and a red light shows when the throttles are pulled back.

Landing Gear Door Operation

Forward section of nose wheel doors is operated directly with push-pull rod actuated by the gear retracting link. As the gear extends, the front door opens fully to allow the wheel to pass

Front view of main landing gear, looking aft, showing double struts. To facilitate removal and servicing of wheel, link (1) on cylinder is swung down to engage hook (2) on piston, attaching bolts (3) are removed, and when plane is lifted at jackpoint (on cylinder behind link hinge), link raises piston away from axle to permit wheel to be rolled from under strut. Doors (4) remain open after gear is extended.



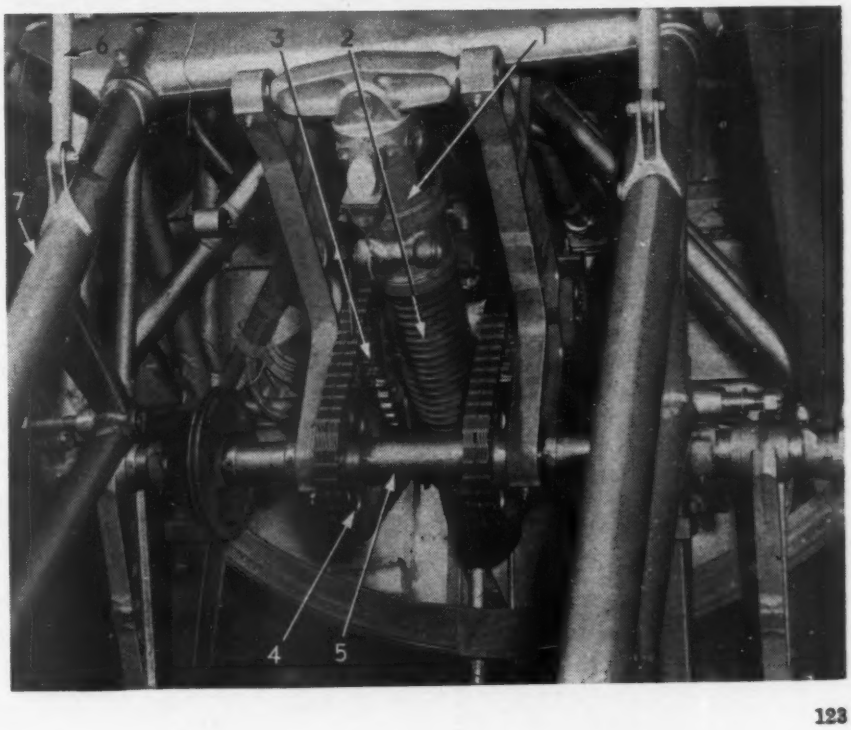
and is again closed when the gear has reached fully extended position. Rear doors remain open after the gear extends. They are operated by push-pull rods actuated by two arms (on a torque shaft mounted on housings on the vertical beam in the nose section) in turn operated by push-pull rods actuated by movement of lower nose gear truss. Side frames of the truss have welded hinge brackets which provide attachment for the operating rod.

Nacelle doors, because of their great length, are actuated at front and rear by a parallel system of torque shafts and arms interconnected by cables. Main operating arms are hinged on main landing gear torque shaft and are held in the door-open position by torsion springs on the rear torque shaft. Operating arms are combination arm and pulley arrangements. The door-operating push-pull rods are fastened to the ends of the arms, and cables anchored to the pulleys run to the top of the landing gear well over two sets of guide pulleys to similar pulleys of arm and pulley arrangement hinged on a torque shaft at the rear of the well. At the end of these arms, door-operating push-pull rods are hinged.

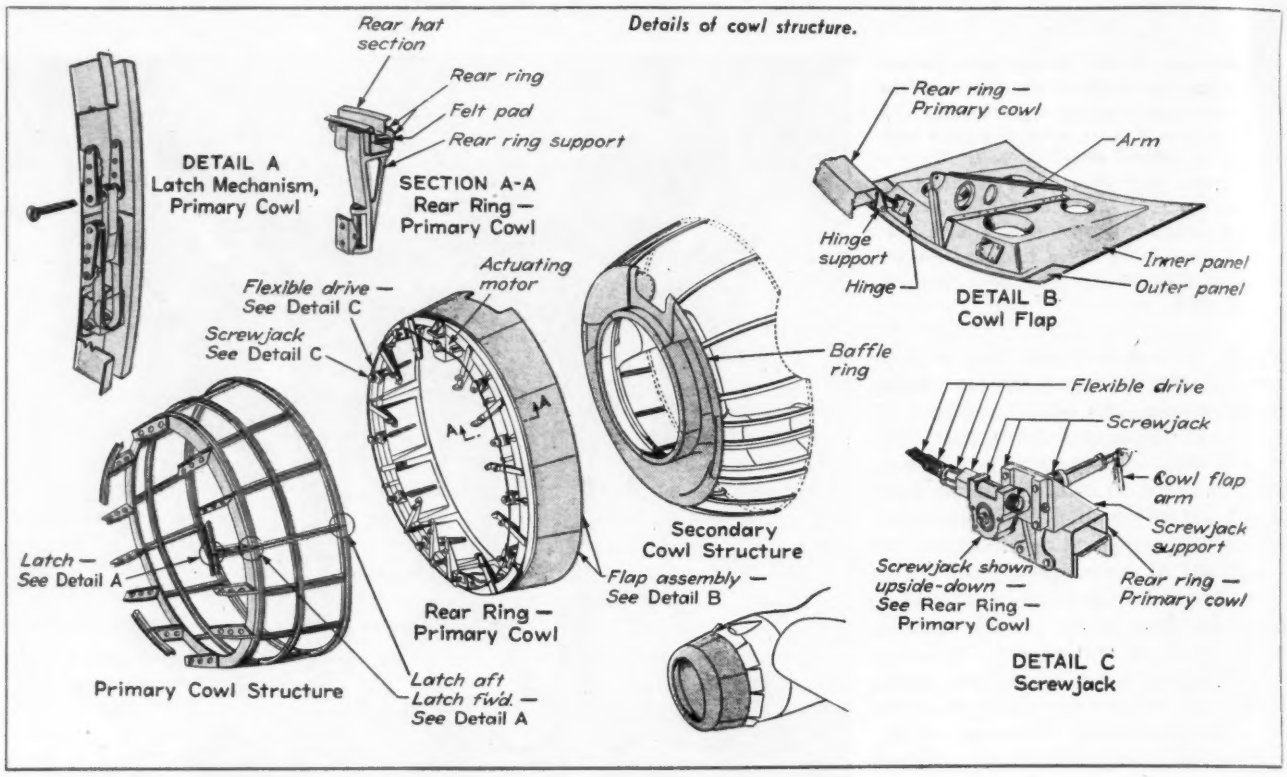
After main landing gear torque shaft has moved through $\frac{3}{4}$ of its full travel, it picks up the actuating arms and carries them with it as it moves to the fully retracted position. Nacelle doors remain opened when the landing gear is fully extended.

Brake Hydraulic System

Pressure for operation of wheel brakes is obtained from 1,000-psi. hydraulic system. A motor-driven gear-type pump maintains pressure in two accumulators separated by check valves. One accumulator supplies pressure to the power brake valves connected to the outboard units of the dual duplex brakes, while the other supplies the valves connected to the inboard brake units. This, in effect, provides two independent systems for the operation of the brakes, and failure



Landing gear retracting mechanism: (1) Actuator, (2) boot over actuating screw, (3) upper sprocket, (4) lower sprocket, (5) torque shaft, (6) hydraulic snubber piston, and (7) upper drag strut.



Details of cowl structure.

of one of the systems results in the loss of only half of braking capacity. In event of power failure, the accumulators, when fully charged, are of sufficient capacity to safely bring the plane to a stop.

System pressure is regulated by a starbird type pressure switch with power contacts adjusted to close at 980 psi. and open at 1,160 psi. Warning light contacts, adjusted to close at pressures below 800 psi., energize indicator lamps located on instrument panel, to warn pilot of failure of pump to maintain normal system pressure. Pressure gages attached to the air side of accumulators and mounted on the instrument panel indicate preload air pressure when accumulators are discharged and hydraulic pressure when accumulators are charged.

Power Plant

Two P & W R-2800, type C, twin row radial engines, each rated at 2,100 hp., power the Packet. They have single stage, two speed internal superchargers, two-position spark advance, built-in torquemeters, manifold pressure regulators, and Hamilton Standard three-bladed constant speed propellers, 15 ft. 2 in. in diameter.

Each engine is suspended on six flexible brackets on a conventional steel tubular mount bolted at four places to the nacelle structure through which the loads are carried to the wing.

Primary cowl is NACA type, fabricated in three radial sections fastened together and to two support rings on the engine by trunk-latch type fasteners.

Support rings consist of circular channel sections and mounting brackets which fasten the rings to the engine rocker boxes. Rear ring also serves to mount cowl flap hinge brackets, operating motor, and actuating screwjacks. The jacks are operated in series by flexible torque shafts, which, when assembled, form a continuous drive.

The secondary cowl consists of a stainless steel baffle ring and five detachable cowl panels. The baffle ring separates the power zone from the accessory compartment. The cowl panels are supported on the baffle ring in front and the firewall in the rear. Portions of the baffle ring and cowl flaps are cut out to provide for the installation of the air induction scoop at the top and to afford openings on each side for installation of heat exchangers. Between the baffle ring and firewall, a stainless steel well is formed around each heat exchanger to protect the accessory compartment from heat and fire.

The exhaust system consists of an exhaust collector, two heat exchangers, and two tail pipes for each engine. The collector is supported on the engine mount structure and connected to the engine ports by flexible joints. Each collector has two outlets, one on each side, to exhaust the gasses through the heat exchangers and outboard through the tail pipes.

Front end of the heat exchanger is supported on the exhaust collector and rear end on the tail pipe, in turn supported by two levers—one on top and the other on the bottom—designed to allow for expansion of the collector and expansion of the heat exchangers.

On the centrally located pedestal, are two engine control quadrants interconnected by torque tubes. Push-pull rods connect the control levers to arms on the horizontal torque tubes. Arms from the center of these tubes are connected by push-pull rods to irreversible bellcranks which prevent creeping of the control levers.

A series of parallel push-pull rods extend aft to the wing front spar, branch off to either side, and follow the spar to the nacelle. At this point a group of bellcranks turn the rods forward to other bellcranks on the front face of the firewall. The propeller and carburetor air controls follow the firewall to a point opposite the controls on the engine to another set of bell cranks. Flexible push-pull controls pick up and go to the propeller governor and the carburetor air valves. Throttle and mixture controls run to the outer part of the firewall to a set of bellcranks, where quick disconnect push-pull rods go forward to the engine levers.

Fuel and Oil Systems

Fuel is carried in four tanks located in the wing between the front and rear spars—two consisting of 4 interconnected cells each, and two consisting of 6 interconnected cells each. Each cell has a 10 x 16 in. opening at the bottom reinforced with a molded rubber fitting with metal ring insert to which is bolted an access door.

At each corner of the side walls are ⅞-in. fittings—the upper to vent the cell and the lower to permit the flow of fuel from one cell to the other. Be-

tween the two lower fittings is located a 2-in. fitting to allow a greater flow when the tanks are being filled. Flapper valves cover these lower fittings to retain fuel over the fuel outlet when the airplane is in a bank. Adjacent cells are bolted at each fitting to the wing rib which separates them.

On the upper wall of each cell are 10 snap-type hanger fittings to prevent the cell top from collapsing.

In the access doors of four cells are provisions for mounting a submerged type electrically operated booster pump to insure adequate fuel pressure at takeoff and high altitudes, and also to prevent vapor lock at high altitude. In event of failure of the engine-driven pump, the booster pump may be used to afford adequate fuel supply.

The four tanks are piped so that left tanks supply fuel to the left engine, and the right tanks supply fuel to the right engine. A transfer system connects these two independent systems so that in the event of failure of one engine, the fuel can be transferred for use in the other. Both engines can be operated from fuel in any one tank.

Fuel is brought together at a selector cock operated from the cockpit, to enable pilot to select the desired tank, then flows to a strainer and finally to the engine-driven pump. Between the selector cock and the strainer is installed an emergency shut-off cock located on the aft side of the firewall, to permit pilot to close the fuel supply at the firewall in the event of engine fire. This cock is electrically operated and the same actuator is used to simultaneously close the oil emergency shut-off cock.

The bladder type cells may be replaced with self-sealing fuel cells without necessitating structural changes.

Two elliptical 55-gal. oil tanks—magnesium alloy or self-sealing units—are strapped in cradles provided on the nacelle structure, and incorporate a hopper to segregate the diluted oil and aerate the oil returning to the tanks.

From the outlet at the bottom of each tank, the oil flows through an electrically operated emergency shut-off cock to the engine. Two bosses on the inlet fitting at this shut-off cock accommodate both the oil dilution line and the drain line.

Oil from the engine is passed through elliptical aluminum alloy oil coolers equipped with type D-9 oil temperature regulator valve which allows oil to pass through the cooler or bypass around it. Surge protection is also provided to protect the core of the cooler from damage because of excessive oil pressure. From the coolers, oil is led back to the tanks for re-circulation to the plane's power plants.

In event of damage to one of the tanks, both engines can be supplied with oil from the other tank. This is accomplished through a transfer system consisting of a four-way two-position selector cock and a hand wobble pump.

Electrical and Communication Systems

With the exception of the hydraulically operated wheel brake, the Packet uses electrical power. A 24-v. d.c. single wire bus system supplied by a 34-amp.-hr. battery, 200-amp. high-speed generator driven by each engine, and a 200-amp. auxiliary power plant, furnishes power to 52 separate circuits, which make up the wiring system. All wiring, with the exception of the ignition system, is of the open type and is supported by quick-opening cushioned clamps. Wires are protected, where necessary, by Vinylite insulating tubing.

The bus system extends from the main junction box (located in the cargo compartment) from which three branches lead—one to each junction box in each nacelle, and a third to a nose junction box.

Two inverters are used to supply 440-cycle a.c. to operate the automatic pilot and radio equipment.

Radio equipment consists of 10 receivers and 6 transmitters, to which are led 14 externally mounted antennas. The twin boom and large fuselage permit the use of long antennas, widely separated from the structure, for the command and liaison sets.

Two command sets are used—one of high and one of very high frequency—for short range plane-to-plane and plane-to-base communication. A liaison set is used for long distance plane-to-base operations. Two radio compasses permit simultaneous bearings to be taken from two ground stations, while two radar sets—one of short and one of long range—are used for avigational purposes.

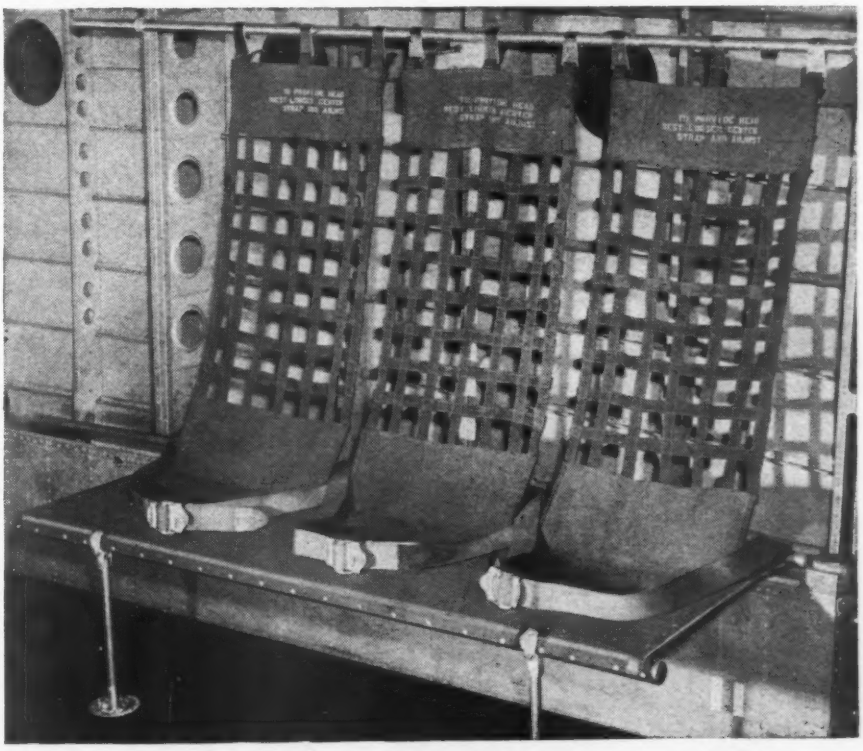
An absolute altimeter indicates the altitude of the plane above the terrain. To facilitate landing in bad weather or at night, blind landing equipment is also provided.

An identification set and six interphone stations complete the radio system.

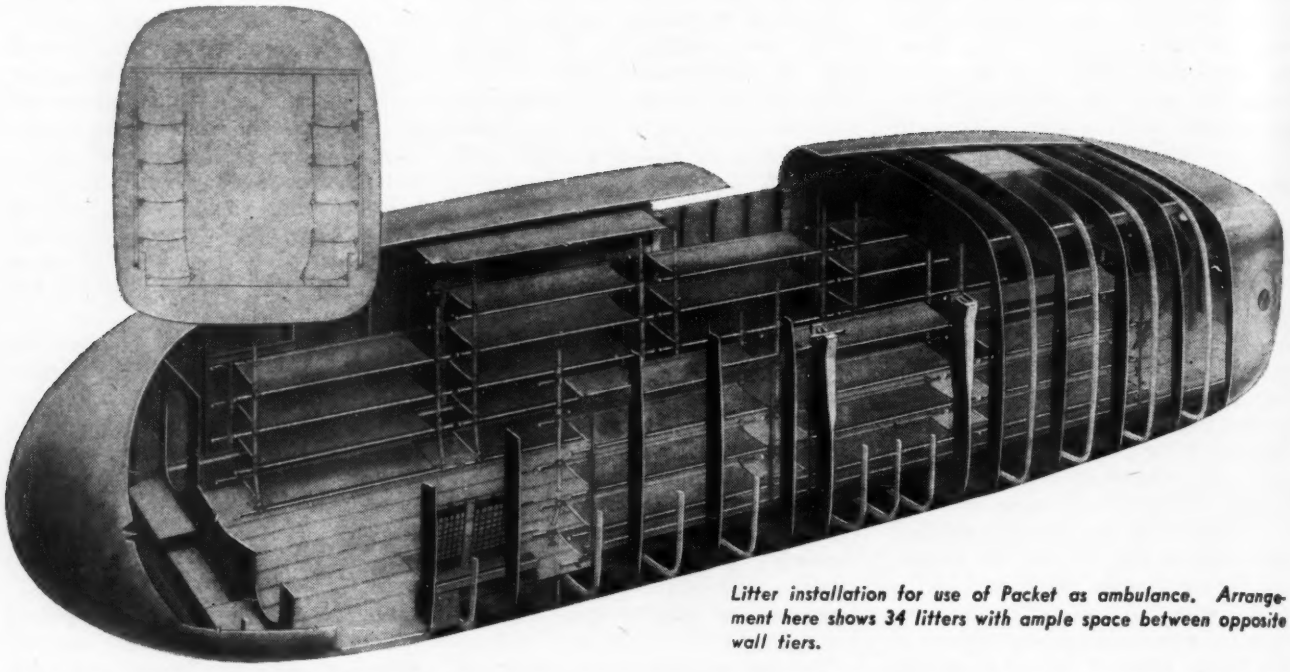
Equipment and Furnishings

On a centrally located cockpit pedestal are mounted controls for engines, propellers, tabs, and landing gear, and switch and circuit breaker panels. Radio controls are installed on overhead panels in the center of the cockpit, within reach of pilot and co-pilot. Interphones, oxygen equipment, heated-suit rheostats, map case, emergency axe, and first aid kits are mounted on cockpit side walls.

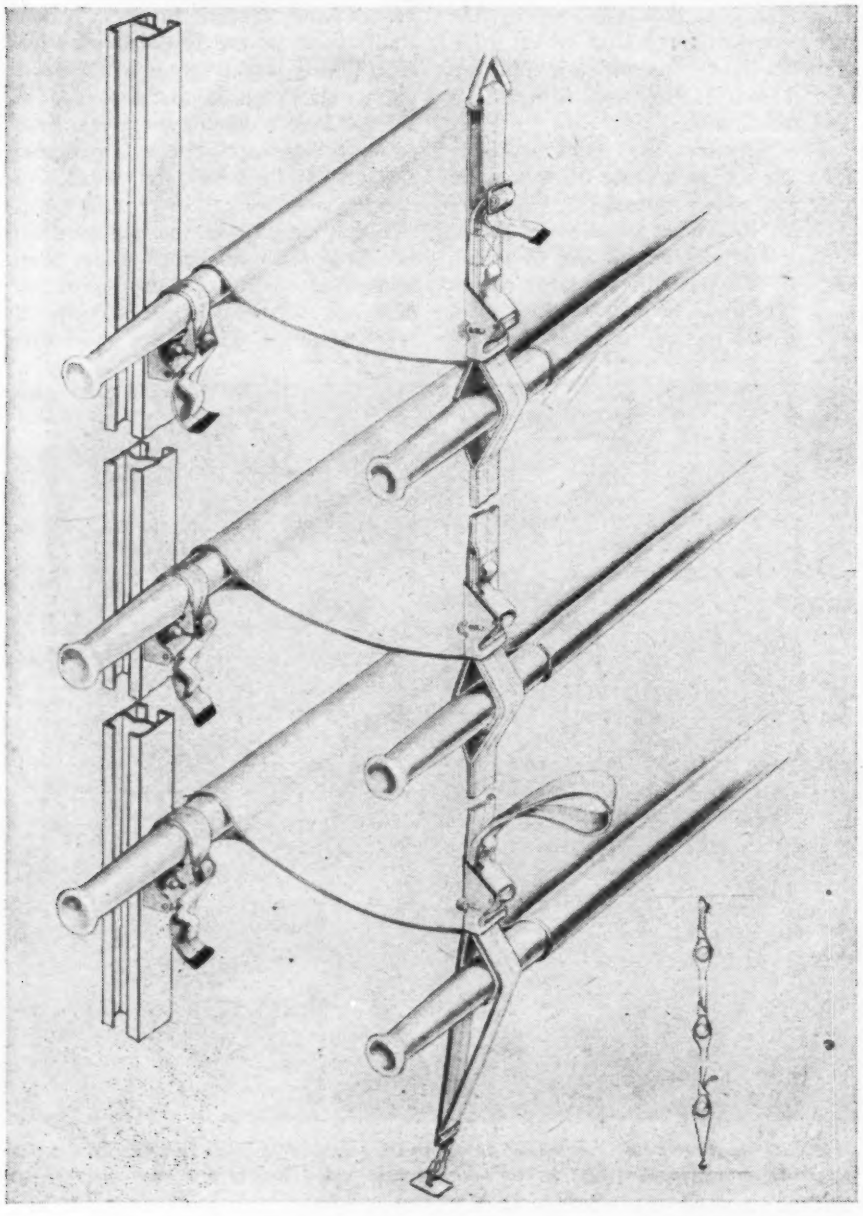
Flight and engine instruments are installed on a large shock-mount panel hinged at the bottom for tilting 45 deg. aft to provide accessibility to rear of panel. The entire panel may



Section of the canvas seat installation. Legs, attaching to studs in floor tie-down fittings, are hinged to lie against front tube of seat when latter is folded back to give clear cargo space.



Litter installation for use of Packet as ambulance. Arrangement here shows 34 litters with ample space between opposite wall tiers.



Details of litter suspension. When not in use, suspension straps are folded and stowed in bags on ceiling.

be removed as an assembly by pulling two electrical plugs and disconnecting flexible tube assemblies at bulkhead fittings mounted on a bracket at panel center.

Because of the considerable distance between pilot's and co-pilot's seats, duplicate flight instruments are provided.

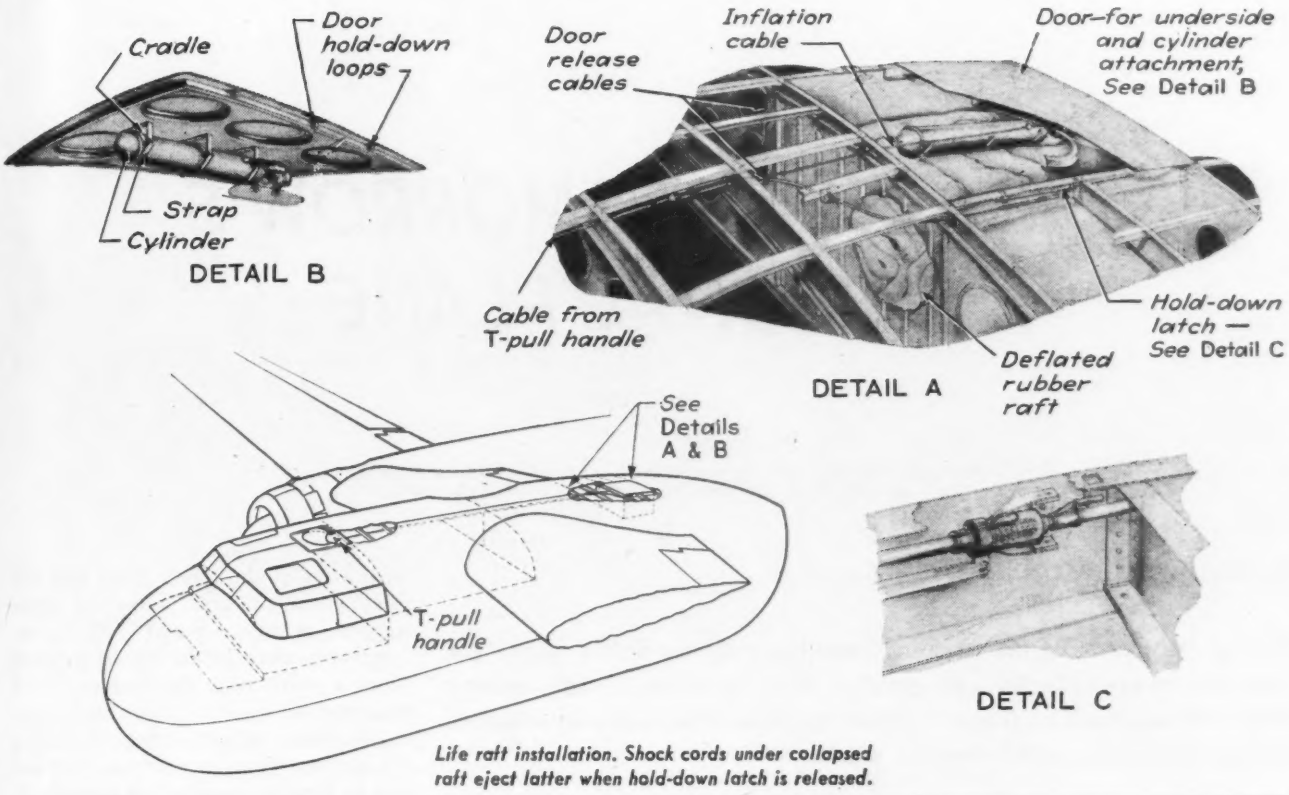
For storage of pilot's and co-pilot's personal effects, a glove compartment is provided at each end of the instrument panel.

Radio equipment is installed on the auxiliary floor to the rear of the cockpit.

Removable soundproofing-and-insulating Fiberglas panels and interior trim cloth are used throughout the entire fuselage.

Forty-two removable canvas seats provided on the sides of the cargo compartment for accommodation of paratrooper or other personnel, are retractable and built in two, three, or four-man sections equipped with safety belts. Each section is mounted on a rear tube rigidly fastened to clamp fittings on the fuselage outboard longitudinal beam, and seat legs are hinged to a front tube. When folded back against the sides of the fuselage, the seats are clear of the cargo space, and when extended the legs are held by studs in the floor tie-down fittings. Seat backs, made of interwoven canvas straps, are hung by hooks from handrails fastened to side beam inner chord members.

As an ambulance plane, the Packet



Life raft installation. Shock cords under collapsed raft eject latter when hold-down latch is released.

accommodates arrangements of 34 litter patients and 5 attendants, or 22 litter patients, 22 seat patients, and 3 attendants, or 13 litter patients, 40 seat patients, and 2 attendants.

Litters are supported between fixed wall brackets fastened to the side of the cargo compartment, and suspension straps are hung from ceiling fittings. Loops (over which are lock fittings) are spaced 17 in. apart to form tiers of 4 or 5 litters. When not in use, suspension straps are folded from bottom to top and stowed in bags located on the ceiling.

The life raft compartment, located in the fuselage upper rear section, is equipped with a canvas cinch with shock cords to support the six-man raft. A pull on the release handle in the cockpit releases the raft compartment door and then opens the carbon dioxide bottle to inflate the raft which forces itself out of the compartment. To prevent the raft from drifting too far before boarding, a mooring rope secures it to the plane. The raft compartment can be used as an escape hatch after raft ejection.

Oxygen System

Pilot's and co-pilot's oxygen installations consist of type A-12 demand regulator, pressure gage, flow indicator, mask, and duration graph. Each of the other crew members have regulator, indicator ,and mask.

For safety, co-pilot's and avigator's demand type oxygen regulators are manifolded to three G-1 oxygen cylinders; and pilot's, radio operator's, and crew chief's regulators are manifolded to five cylinders.

Two portable demand type units are located in the cockpit, convenient to crew members. An additional portable unit is located at crew chief's station in cargo compartment. Five portable rechargers are placed at various points in the plane.

For troops or litter patients there is a continuous flow system supplied by four J-1 oxygen cylinders lashed to the floor in the forward part of cargo compartment and connected to the piping system by flexible hose. Since these cylinders are installed only when required, no permanent mounting cradles are provided. Five continuous flow regulators, located under the floor in the fuselage rear section, supply oxygen to 43 automatic coupling outlets strung along the side walls, for attachment of mask hoses.

The oxygen filler valve is on the left side of fuselage, accessible from the outside. Crew system and troop system are filled from the same valve. A line valve, accessible from the inside, separates troop system filler line from that of crew system, and when the valve is open both systems are filled simultaneously. Since no check valve is used on the cylinders, the line valve is closed after the troop system has been filled, to prevent oxygen from feeding back through the filler line from the J-1 cylinders. If it is desired to extend the range of the crew system by using the J-1 cylinder, the line valve is left open. The G-1 cylinders are equipped with check valves on the filler line side, and hence oxygen from these cylinders cannot feed back into the troop system.

Fire Extinguisher System

Carbon dioxide for the power plant fire extinguishing system is carried in 6 shatter-proof 5-lb. capacity cylinders. Selector valves direct discharge to either engine, as desired.

Discharge of CO_2, and selector valve setting, is accomplished with solenoids controlled by selector switches mounted on cockpit control pedestal.

In the engine power zone, nozzles located at the rear of the base of each cylinder discharge the gas in fan-shaped pattern. In the accessory compartment, a perforated ring is used. Individual leads run to nozzles in the carburetor air induction system blast tubes and the heat exchangers.

Acknowledgment: This analysis of the Fairchild C-82 Packet was made possible by the generous aid and cooperation of the management and engineering departments of Fairchild Aircraft Div. of Fairchild Engine & Airplane Corp., Hagerstown, Md. Particularly credited are M. Cozzoli, project engineer; W. O. Hammer, assistant project engineer; group leaders H. L. Stroud, wing; W. P. Maloney, fuselage; C. W. Jones, empennage; M. A. Cawl, control surfaces; C. E. Hammer, electrical; F. L. Boucher, landing gear; N. C. Bryan, power plant; T. Hoffacker, fixed equipment; and G. N. Fryer, engineering illustrations. Appreciation is specially extended to J. H. Wales, Jr., assistant to general manager, for his valuable assistance.

DESIGNING TOMORROW'S PERSONAL PLANE

PART IV

With "Spot" Sketches of Early Pushers, Courtesy "Man's Fight to Fly," by John P. V. Heinmuller, Funk & Wagnalls Co., 1944

By RALPH H. UPSON, *Consulting Engineer*

Posing the puzzle of the pusher, Consultant Upson deftly gages the inherent arguments for and against this "problem child"—giving requisite emphasis to those "hidden" traits so frequently overlooked in considerations of this type of craft.

Now comes the pertinent question: What is the matter with our first born—that is, the pusher? Not only was the pusher first to fly; it was also the type used by most of the early designers. Apparently a 'natural' for further development, it has been an object of care and attention ever since, its proponents including, at various times, some of the best brains in the business.

Yes, it still has an undeniable appeal and a mystic quality that, to many people, seem to mark it as the airplane of the future. Yet where has it gotten? Nowhere—beyond experimental and discarded units, pretty pictures, and design contest winners (on paper). Not a single major class of aircraft, military or commercial, can claim the single-engine pusher as a recognized service type today.

Why? And is the case of the pusher utterly hopeless, lost in the 'original sin' of basic defects? Or is there still some reasonable hope of salvation?

Although some considerations apply almost equally to any class of plane, the worst features of pusher construction seem especially reserved for that size and class suited to limited commercial and family use discussed in these articles.

Except as otherwise mentioned, the term 'pusher' will here signify the usual conception of a single engine and propeller combination for a landplane, with no extension shaft or other distant transmission. Comparison will be with a tractor of similar qualifications.

The insidious thing about a pusher seems to be that, although certain advantages are quite obvious, its usually overbalancing disadvantages are well hidden from the casual gaze—in fact they are so completely concealed that many ostensibly authoritative discussions of the pusher completely fail to mention the most basic of its many faults

Center of Gravity

For illustration of a principle, and with apologies to those who have been through all this before, let us suppose that the power plant weighs 300 lb. and that the complete tail, including adjacent structural parts, weighs 100 lb. These represent the major elements of fixed weight that may be located at substantial longitudinal distances from the center of gravity.

The desired airplane C. G. Position is, of course, that corresponding to the minimum size tail which still insures safe stalling characteristics for any condition of flight, normally at about 30% of MAC as shown in our accompanying page 130 figure (which depicts two of five craft types sketched in Part II of this series, July AVIATION). The normal tractor has moment arms of the power plant and tail roughly in inverse ratio to their weights, or say −5 and +15 ft., respectively, thus balancing each other about a point near the desired C. G. position.

All other weights, then, including the landing gear as a whole, can and will be located close to the same C. G. Since these items include all variable weight, it follows that the C. G. of the entire airplane will remain substantially constant in position. In actual practice, there will of course be some variation due to the lack of an ideal balance of weight empty, and to the fact that specific variable items, such as baggage and individual persons, will not all be put exactly at the airplane C. G. For a well designed tractor, however, such variations are of small magnitude.

Quite different is the situation with a pusher. Here (as shown in the same figure) the power plant and tail are both behind the desired C. G. position; and, instead of balancing each other, they add up to a positive moment of 2,100 ft.-lb. Remembering that it is the backward travel of the C. G. that must be most definitely limited, this moment can be balanced only by weight that is always available.

Out of an assumed three places, with baggage, the only weight that can normally be depended upon is a lightweight pilot and the fixed accommodations for all occupants. With a reasonable allowance for all these items, it appears that they must be centered about 7 ft. forward of the desired farthest-back airplane C. G. position.

Of the remaining variable weights, fuel will be about at the C. G. as usual, and baggage may be tentatively so assumed. This leaves about 400 lb. for passengers and additional weight of pilot. To try to put the passengers under the C. G. is to put them almost

under the engine where, even if room vertically were provided, the required width would seriously affect the body streamlining. About the best that appears feasible is to put the pilot alone in front and the two passengers behind, with reasonable leg room between.

Suppose that this 400 lb. acts on an arm of −5 ft. and that the total airplane weight is thereby increased from 1,600 to 2,000 lb. (with light baggage and fuel). Then the forward movement of the C. G., due to the added weight, is 5 x 400/2,000 = 1.0 ft., or about 17% of an MAC of 6 ft.

This figure is likely to be increased by variations in fuel, baggage, and special equipment. Also, notwithstanding the CAA standard of 170 lb. per person, there may on occasion be a good 100 lb. more of live weight to carry (this item alone increasing the C. G. travel to 20%); and, although it is easy to say 'take it out of the safety factor', the plane still has to be controllable.

Other things being equal, this required controllability can be maintained only by a suitable increase in the tail length or area. This increase, in turn, can be partially utilized to put the rearward C. G. slightly farther back on the wing than would otherwise be safe; but still the tail for a pusher must be considerably larger and heavier than for an equivalent tractor craft.

A further influence in the same direction is the need for more vertical tail area to balance the de-stabilizing moment of the short forward-located body. Experience shows that this increase may be as much as 50% above the maximum required for a tractor.

To sum up the results for a plane of this size and class (see Parts II and III of this series, July and Aug. AVIATION), it appears that the C. G. travel for the pusher type will be at least 20 to 25% of MAC, as against 5 to 10%, at most, for a well designed tractor.

Practical Effects

Incidental variation in the C. G. position and travel will of course be affected by design incidentals. On the credit side is any piece of fixed equipment that can be put forward, including the nose wheel of a tricycle gear, instruments, radio, battery, etc., but it must be standard with the airplane so as to be included in the design-weight balance sheet. Similarly any relative saving in the tail or engine weight will not only give the usual direct benefit of weight saving but, by reducing the C. G. travel, prevents as much weight increase as would otherwise be necessary.

Another approach to the same problem is to get the wing's aerodynamic center back relative to the engine, by means of a center cut-out or by sweepback of the outer panels. Either is a choice of evils, for one will increase the drag while the other is conducive to tip stalling. The latter, however, can be minimized by negative twist (washout).

For any ship with a relatively short cabin, pusher design will naturally be facilitated by minimizing the number of places, a one-place design being by far the best. For two places, tandem seating is definitely better than side-by-

side; and for three places, as already indicated, the double seat should be aft rather than forward.

With more places, and higher power, the difficulty is increased. In addition to the increased tail weight (which starts a vicious circle), a pusher with cantilever wings (or single strut) is also subject to weight increase from tail torque carried through the wings (for the usual twin-boom type). More weight is involved in the greater nose length forward of the wing, the added wing area required to carry the down load on the tail, and indirect increments connected with other difficulties to be mentioned.

But returning to the center-of-gravity business, the C. G. travel is not only of serious magnitude, but in the wrong direction, making it most difficult to get the tail down just when it is most important to do so—i.e., when taking off or landing with a full load. The elevator area and deflection required to get the tail down at all under full load are sure to be excessive for light load.

Hence, although it may be possible to make a three-place pusher spin-proof or safely non-stalling, at least it has never yet been done as far as available records go. Similarly, if the degree of stability is to be correct at light load, it will be excessive, with much heavier elevator forces, at full load. Tricycle gear, otherwise so attractive for a

pusher, tends toward excessive takeoff speeds at full load, and towards tilting backward onto the tail with little or no provocation when empty.

It was formerly thought that the relative freedom of the pusher from trim disturbance as between power-on and power-off would largely compensate for the C. G. travel, but there are now well established methods of getting substantially equivalent results with a tractor.

Short of extension shaft and more heroic or long-pull measures to be discussed later, there are, we grant, various expedients that *might* be used in fighting this C. G. difficulty. In fact, so many have been considered by those faced with the reality of the problem that it's quite likely any so-called 'new solution' today has in reality been thought of before. In this class may be included—

(a) Liquid ballast to be pumped between nose and tail tanks.

(b) A heavy 'bow-sprit' to be worn on the nose (of the airplane!) for light load, on the tail for heavy load, and carried inside for intermediate loading.

(c) A nose ballast bin, with weight-indicating scale, to be loaded with rocks or anything that will show on the scale a weight corresponding to what is specified for different loading conditions.

(d) A bungee trim adjustment (preferably separate from normal cruising trim), either set manually within certain limits in accordance with directions, or automatically responsive to weight in the seats, etc.

(e) Similarly variable elevator stops.

But before actually adopting any such Goldberg-ish schemes (with flying already more complicated than it should be for the non-professional pilot), let us see if the pusher is really worth the effort.

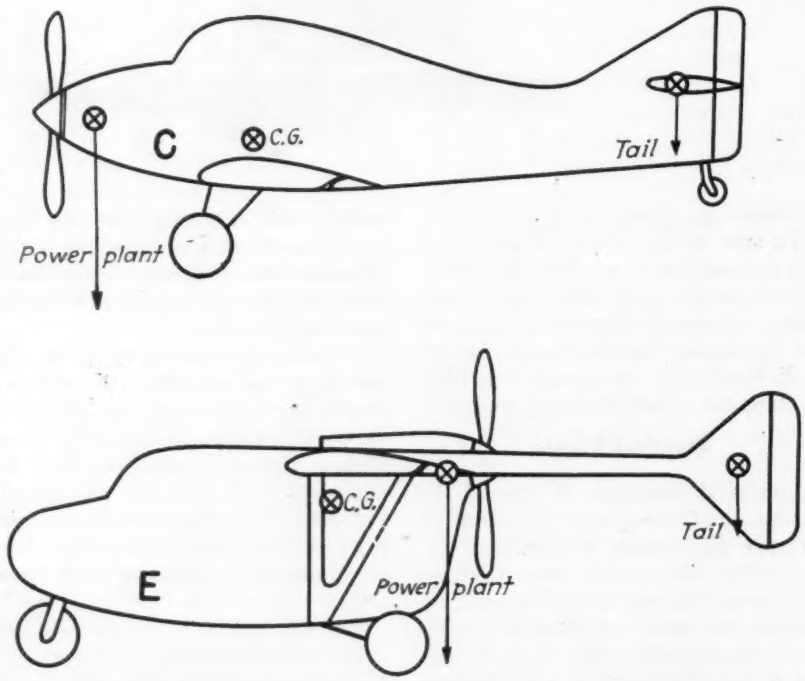
Miscellaneous Pros and Cons

If the pusher in its present state of development is to have serious consideration, it must be for reasons of safety, and these boil down to two major items: Vision and propeller protection, with the argument on neither of them entirely one-sided.

The pusher proponent says: "Avoid crashes by insisting on the nearly perfect vision which only a pusher can give." Yet experience in World War I and more recent statistics show that accidents happen to pushers as well as to tractors; and that when they do happen the pusher occupants are more liable to serious injury[1]. Still, the number of cases and design types are not yet sufficient to be conclusive for precise evaluation of vision values; the question simply remains unanswered as to whether the improved vision of a pusher in preventing accidents is sufficient to overcome its demonstrated disadvantage in case an accident occurs.

Here it should be brought out that the biggest disadvantage of a conventional high-wing tractor is not that it is a tractor but that in normal flight the pilot sits under the wing where he is blind in a turn; and, further, the landing angle is such that the whole fuselage nose is thrust up into his line of sight. The latter condition is obviously worst with a cowled radial engine. A low-wing tractor with an inverted or flat engine, a low landing angle, and with pilot seat well forward, has surprisingly good vision, as anyone can testify who has given it a fair trial.

On the subject of propeller protection, the point is often missed that a propeller fitted behind out of the pilot's sight, *must* be well protected or it is definitely *more* dangerous than in front. A twin-boom pusher appears, off-hand, to give very good protection;



In tractor craft C and pusher E (two of five type designs represented in Part II, July AVIATION), positions of desired C. G. and moment arms are indicated to illustrate balance of power plant and tail moments in tractor type and additive moment effects in pusher type.

but a high wing, that affords the best vision and other advantages, puts the wing and booms too high to "fence off" a drome-wandering child, unless there is further protection by wires or struts.

An apparent basic danger to any pusher propeller is of being damaged by loose objects: A nut, piece of cowling, wire, ice, or something thrown out of the craft's window or tossed up by one of the wheels. Aside from some scarring of the propeller itself, however, experience has failed to justify much serious concern on this score, especially with metal blades. (But if a pusher should ever throw a blade, there is of course more danger of vital structural damage than with a tractor.)

More serious is the aerodynamic interference of objects in front of a pusher propeller which, with blade resonance, has been known to cause complete propeller failure. In less obstrusive form such interference is a source of high drag, particularly the induced type, and of substantial propulsive efficiency loss.

As is well known, the slipstream from a tractor propeller, although increasing the frictional drag, tends to flush out dead air in its path, increase the wing-lift coefficient, and relieve many a situation that produces high separation drag in the less important power-off condition. Due to the shortness of a pusher body, such help would be more welcome here than with a tractor; but, instead of help, the air flowing into a pusher propeller seems to act on nearby blunt objects in a manner to increase their drag.

The few low-wing pushers that have been otherwise successful have shown substantial power loss from such causes. And even the high-wing type still involves relatively blunt body lines, and an engine form which, in its usual location relative to the wing and propeller, is certain to interfere with both.

Flaps, also, set up a troublesome problem, especially with the usual horizontal-opposed engine. It is apparently impossible to put effective flaps on the wing portion occupied by the engine; and the remaining portion out to the booms seems hardly enough to be worthwhile, especially in view of the possible harmful propeller interference from more than moderate flap deflection.

In any case, the effective flap span is considerably reduced, with a substantial gap at mid-span. The latter increases the induced drag to an extent especially interfering with the use of the flaps in takeoff. The maximum lift, power-on, is further sacrificed by loss of the slipstream reaction on the wing.

After all these real troubles, the slight further weight and complication of providing adequate cooling for the engine seems hardly worth mentioning. The same applies to minor advantages, such as the avoidance of an extra step to get in, and the reduction of propeller and slipstream noise.

If we add up the score for a three-place high-wing tricycle pusher (as was done with weight, drag, and performance in Part II of this series, July AVIATION), then using an optimistic estimate by granting most benefit of doubt to the pusher, we get results roughly as follows for the pusher in comparison with a low-wing conventional tractor of equal carrying capacity, cruising speed, and range:

Weight empty and cost	21% more
Length and span (av.)	15% more
Fuel consumption	46% more
Top speed	4% less
Takeoff	About same[2]
Landing	A little faster and longer
Vision	Somewhat improved
Safety in crash	Definitely worse
Propeller protection	Generally better
Over-all safety	Doubtful improvement

The pusher is assumed to be strut-braced, for reasons already brought out, to minimize separation drag and structure weight, and for propeller protection. The greater difficulty of retracting the wheels of the pusher is side-stepped by comparing the planes on a basis of fixed gear for each. The conventional landing gear for the tractor and the tricycle gear for the pusher, represents the best structural arrangement for each type (see design Types C & E, Part II, July AVIATION).

Tailless, Canard, and Others

The serious penalties, above listed, cannot be laughed off; but perhaps they can be reduced by basic design developments, or to a certain extent accepted, as justified for special purposes.

One partial solution that suggests itself is to get rid of the troublesome tail moment by leaving off the tail—or, to go a step further, adopt the 'canard' type, where the power plant and tail positions are simply reversed. Although a detailed discussion of these essentially distinct types is beyond the province of this article, we may at least make note of certain characteristics requiring careful attention if new pitfalls are to be avoided:

First, although the C. G. travel is decreased, the range for satisfactory stability and control is also decreased in either type. In the case of the tailless, reason for the extremely short stabilizing and control arm is obvious. Its ability to cope with any C. G. travel is correspondingly limited; and flaps (in the usual sense for effective lift increasing) are out of the question. Far from any *increase* of lift coefficient at landing (barring unforeseen innovations) a tail-less can normally be expected to show *less* lift than a conventional unflapped airfoil. Thus, in round numbers compared to a 'regular' airplane with good flaps, a tail-less must pay for its docked tail by adding to its wing more than five times the tail area saved, still without considering the problem of lateral (including directional) stability and control.

This difficulty is not entirely avoided merely by sticking the tail out in front, unless with a wholly impractical length. The main trouble here is that, for a front tail-plane, stability ordinarily

requires a little more lift coefficient than carried by the wing, plus another increment to balance the wing-moment coefficient. Then any allowance for C. G. travel must be taken out of what remains of the available lift coefficient.[3]

As an example, take a rather liberal front-tail area equal to 20% of the wing's area, on an arm of 2.5 MAC between aerodynamic centers. Suppose that the maximum usable tail-lift coefficient is 2.4 and that for the desired minimum stability the rearward C.G. is 0.5 MAC forward of the wing's aerodynamic center. This puts the weight of the wing itself considerably behind the C. G., which must be balanced mainly by variable load forward. But let us assume that the C. G. travel can be held to .12 MAC, which puts the forward (full load) C. G. at 0.62 MAC. Taking moments, in wing coefficient form, about the latter point, and neglecting the moment coefficient of the tail surface —

$$0.2 \times 1.88 \times 2.4 - .62C_L + C_m = O$$

[1] De Haven: "Causes of Injury in Lightplane Accidents," Mar. 1, 1944 *Aero Digest.*

[2] Including allowance for induced interference and reduced flap effectiveness.

[3] J. V. Foa: "Proportioning a Canard for Longitudinal Stability and Safety Against a Stall," *Journal of the Aeronautical Sciences*, Dec. 1942.

If the wing has $C_m = -0.02$ (43015 airfoil), the balancing $C_L = (.90 - .02)\ .62 = 1.42$.

or, including the tail lift:

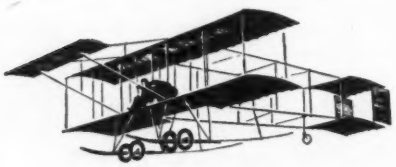
$C_L = 1.42 - 2.4 \times .2 = 1.90$

Obviously, for these conditions there is no use for wing flaps. Yet if you don't have flaps to provide a margin against wing stalling in the lightly loaded condition with rearward C. G., the maximum tail lift will have to be reduced to a value which, if applied to the full-load condition, will still further reduce the maximum lift which can be realized from the wing.

Although the above over-all lift coefficient is fairly good, it could be about 30% better with a normal tail and with wing flaps as efficient as here assumed for the front tail. At a penalty of increased drag, the tail loading can be reduced by lowering the aspect ratio of the tail-plane. On the other hand there appears some question as to whether its assumed maximum lift coefficient can actually be utilized and still leave a satisfactory margin for maneuvering and gusts.

The big control difficulty in this type of plane is not spinning, which is readily avoided by making the tail stall first, but a vicious nosing down when the tail stalls, especially with tail lift coefficients of the magnitude here assumed, and with due consideration of the component due to pitching motion.

Best solution of the directional stability and control problem for the canard, as well as for the tail-less, is

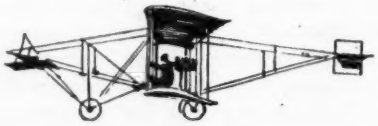


apparently wing tip fins and rudders, which must total more area than in the usual rear-tail position, but on the other hand act to improve the effective aspect ratio of the wing (if not tapered more than about 2:1).

Use of a low wing is difficult for both these types,[4] not only on account of the stability problem but also because the positive pressure gradient around the rear part of the body or fuselage is just where it encroaches on a similar part of the wing, in this respect the same as a normal pusher.

For vision, a front tail is probably no better and no worse than front engine of the flat type. Like the tail-less and normal pusher, however, the canard body can be mounted conveniently close to the ground, and the long nose will probably be helpful as a control reference.

A hybrid arrangement, offering



some appeal, is a front elevator or trimming surface in combination with a rear tail. Among the more bizarre possibilities which have been seriously suggested, is a retractable tail.

All in all, the tail-less seems peculiarly unsuited to personal use, except for very special purposes, such as perhaps roadability or compact stowage. The canard, in an improved form, shows possibilities, but it needs further research, particularly in practical flight testing. Although no panacea, it still has certain advantages, along with some disadvantages which will be justified only if the final balance sheet can be proved favorable.

Other variations on the pusher theme are the small twin (not here considered), single-boom tail, nacelle type power plant above the wing, and various types of distant drives, including the generally desirable low engine position. Some of these arrangements are particularly suited to seaplanes and amphibians, of which more later, and for which the pusher in general seems to have much more justification than for ordinary landplanes.

The Airplane of the Future?

But still we haven't even touched on the one important consideration which in the future may effectively dictate that practically every propeller-driven airplane must be a pusher. Due to the unavoidably turbulent nature of the propeller slipstream, anything in its path, including the entire fuselage, appears forever condemned to a turbulent type of skin friction.[5] Yet the only chance of reducing the drag substantially below what is already attainable with a generally clean design, wing loading and other things being equal, is to prevent this turbulent type of drag from developing. Thus, eventually, there may be a compelling advantage in the apparent fact that only with a pusher can laminar flow be had over a major part of the total exposed surface. If that object can be attained in practical fashion, the pusher will really come into its own, especially in connection with any or all of the following improvements:

(a) Simple means of fabricating and maintaining an aerodynamically smooth surface.

(b) An unprecedentedly light and compact engine, such as a small turbine (or means of using atomic energy!).

(c) A light, cheap shaft-drive, with gear-down (preferably variable) at the propeller end.

(d) Takeoff assistance, such as cheap rockets or standardized ground equipment.

The propeller can then be put at the real optimum point—the extreme tail end where, in the absence of wing, body, or engine interference, the propulsive efficiency, instead of being lower than for a tractor, will be definitely higher. Although numerical performance forcasts are as yet premature, it seems reasonable to expect, from physical principles, that for a given speed and range, the power expended

could at least be cut in half, compared with the best present-day design.

There, finally, is something worth working for—worth reasonable sacrifice, if necessary, in the incidental characteristics. But, with the collateral improvements noted above, the present disadvantages of the pusher can be largely disposed of.

Hence, although no pusher in the past has stood the test of time, and although none in this class designed by present methods can possibly compete with a well designed tractor, still the pusher appears to bear true seeds of greatness that may in time fulfill the fondest hopes of its many well wishers.

In the coming Part V of this comprehensive series, Mr. Upson will discuss the pertinent subject of roadable and folding-wing craft.

Errata: Readers are advised of two typographical errors in Part II of this series, July AVIATION. Under heading "Power and Performance, third column, page 148, initial paragraph on thrust power contains phrase, "By substituting the assumed 6" .811. . . ." This should have read "By substituting the assumed $\sigma = .811. . . .$" And in second line of Paragraph 6 on climb, exponent should have been added at end of equation, thus:

$$C_m = 17{,}300\ \eta hp./W - 620 \left(\frac{f}{\eta hp.}\right)^{\frac{1}{6}}$$

[4] For an extended treatise on this whole subject, see "Tail-Less Aircraft and Flying Wings", by A. R. Weyl, *Aircraft Engineering*, Dec. '44 and Jan., Feb., Mar., Apr., and May '45.

[5] Dryden: "Turbulence and the Boundary Layer", *Journal of the Aeronautical Sciences*, Jan. 1939.

Self-Contained Subassemblies Feature B-29 Four-Gun Turret

By **P. E. HUMPHREY,** *Aeronautics & Marine Engineering Division, General Electric Company*

Specially designed to meet demands for increased fire power, GE's four-gun turret for the Boeing Superfortress incorporates compact components which make for ease in both manufacturing and servicing in the field . . . Initial installment of a graphic two-part article.

URGENT REQUIREMENTS for more fire power have been created by the tremendous increase in speed of combat aircraft. This increased fire power can be obtained by three different means: (1) Increased range of guns and ammunition, (2) improved aiming to give a greater percentage of hits, and (3) increased rate of fire, either more rounds per minute per gun, or more guns firing simultaneously.

To meet the specific call for greater fire power in the B-29, a special remote-control turret system was designed—to make the most efficient use of the 50-cal. machine gun. In this system, remotely located direct-aiming sighting stations, fitted with computers, make possible better aiming and enable a single gunner to control several turrets. To further increase the strength of the upper forward position, the four-gun turret was added, which has all four guns firing on the same target simultaneously. Remote control makes possible the most compact turret design. Fig. 1 shows the B-29 four-gun turret which mounts in a 41½"-dia. ring.

Comparison of Controls

Essential difference between the local control and remote control systems of gunnery is illustrated in Fig. 2. In the local control turret, the gunner rides in the turret with the guns and operates the turret and mechanically connected sight by turning power on and off with control handles. In the remote system, the gunner aims the sight directly and the turret is driven electrically to follow the sight-position signal. The remote system requires that the turret be completely automatic, since the gunner is not present to perform any operations in the turret manually.

The functions that must be per-

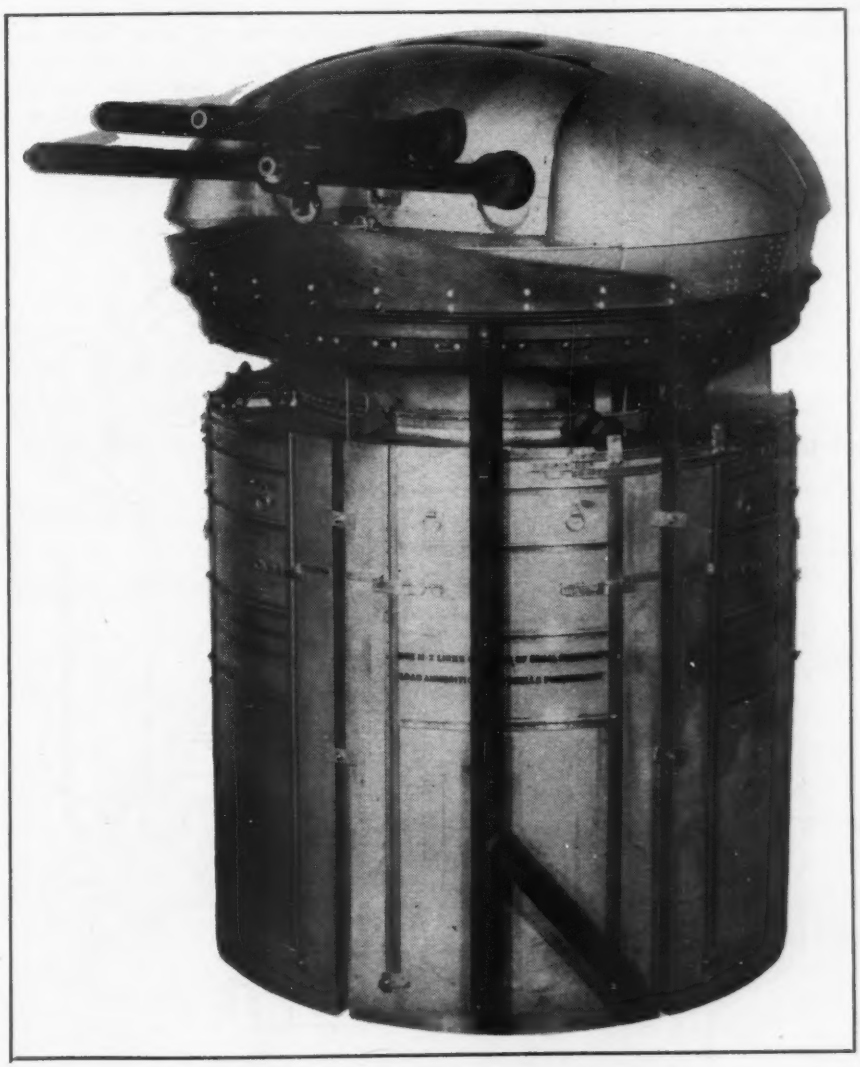


Fig. 1. Fully assembled, GE's Superfort turret reveals striking compactness in a design incorporating numerous "intermeshing" controls, parts, and power units.

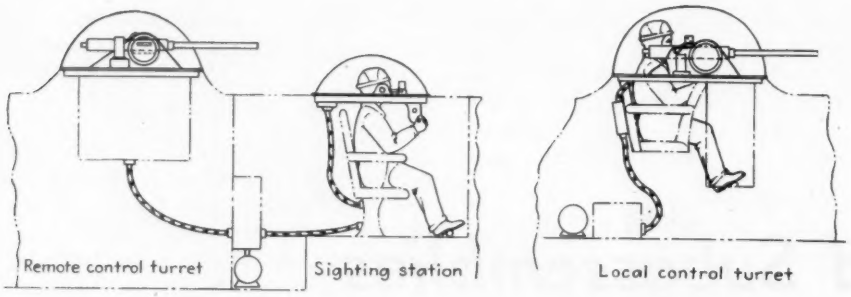


Fig. 2. Sketches compare GE's remote control gunnery system (left) with conventional local control arrangement (right). With remote system, gunner triggers with conveniently handled sighting-control device.

formed by the remote control turret mechanism are: (1) Position guns accurately in azimuth and elevation to agree with the position of the sight, (2) supply ammunition to the guns, (3) interrupt fire when guns are pointed at parts of own plane, (4) mechanically maneuver guns to clear parts of plane in which crew is carried, and (5) automatically re-load guns in case of ammunition jam or stoppage due to a dud. Essential parts of the four-gun turret that perform these functions are shown schematically in Fig. 3.

For ease in manufacturing and servicing in the field, the four-gun turret was designed to be built up of six self-contained subassemblies: (1) Elevation and azimuth drive units, (2) interrupter and collector assembly, (3) ammunition cases, (4) frame and chute assembly, (5) ring assembly and support castings, and (6) dome and enclosure. These separate units are brought together at final assembly.

Details of the turret ring assembly are shown in Fig. 4. The stationary outer ring is made as a stamping from ½" aluminum alloy plate. Outer flange of the "Z" section serves as a mounting flange for the turret, and the inner flange carries the stationary internal ring gear with which the azimuth final-drive pinion meshes. The inner ring is rolled up from an extruded aluminum alloy angle section. Ends are gas-welded to form a solid ring, while the inside surface is machined for mounting support brackets, and the outside is machined for a tight fit with the stainless steel channel roller track.

Special needle bearing rollers mounted on removable bearing blocks are supported in the outer ring. These blocks are assembled from the outside, and washer head screws are used in spline nuts for fastening. Aluminum alloy castings provide the main support for the guns and gear drive units. The saddle support castings are mounted with body bound bolts on aluminum forgings riveted to the inner ring.

Turret Saddle

The saddle (Fig. 5) on which the guns are mounted is carried on two special ball trunnion bearings which are of especially large bore to provide for the ammunition feed. The elevating gear sector is bolted to the right side of the saddle. Guns are mounted on adapters with a rear slider unit

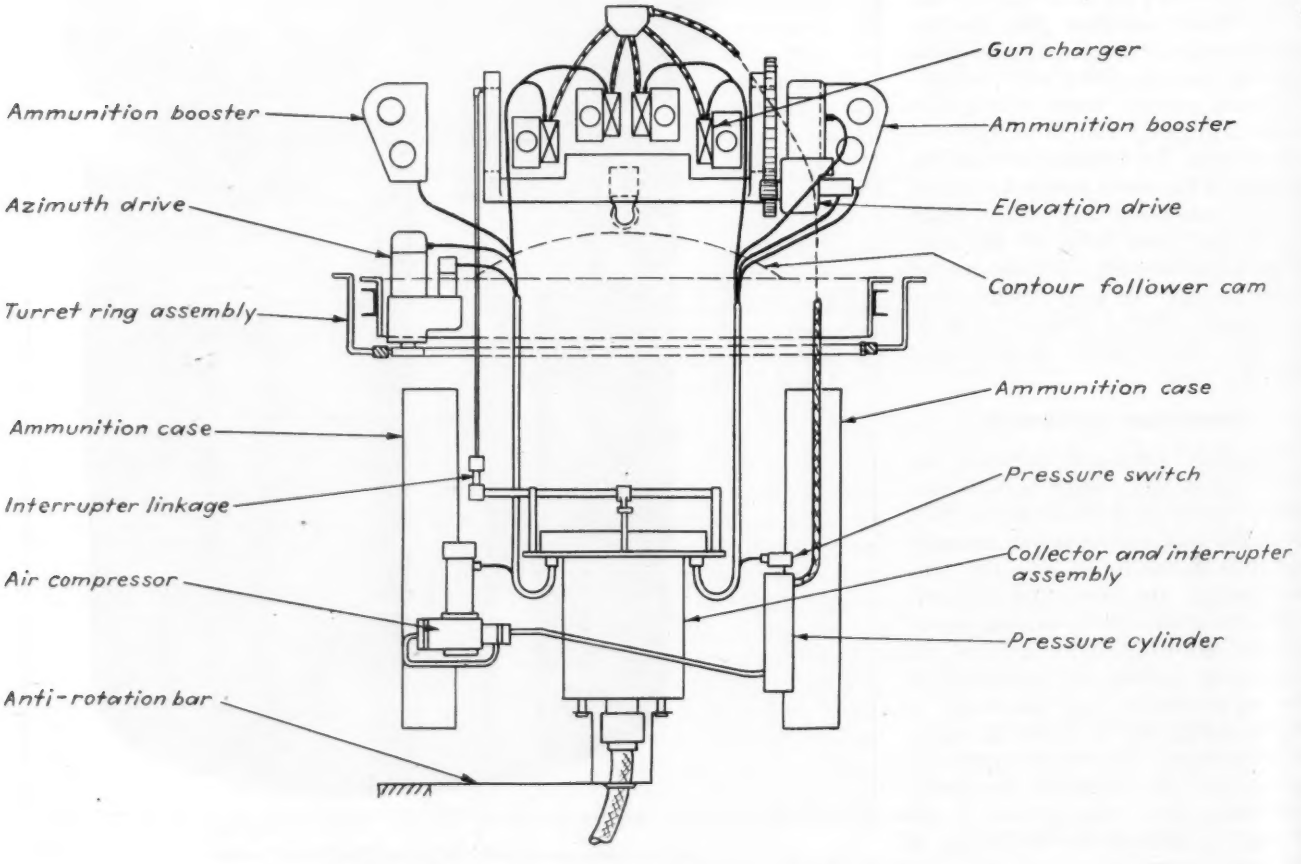


Fig. 3. Schematic diagram indicates major parts of four-gun turret.

providing adjustment for alignment. On this turret, the guns are so close together that they are aligned parallel. Adjustment is necessary to make up for bracket tolerances and variation between guns.

The saddle support brackets provide bolting surfaces for the elevation and azimuth drive units, and the mounting arrangement is such that the final drive pinion mesh is adjustable at assembly. Thus, very close backlash tolerances can be maintained. The elevation drive pinion meshes with the elevating gear sector and the azimuth drive pinion meshes with the stationary internal ring gear.

Drive Units

Details of the drive units are shown in Figs. 6 and 7. To obtain most efficient operation at all temperatures, simple spur and bevel gear reductions are used, and all shafts are ball bearing mounted. To provide a suitable compromise between strength, light weight, and easy machining, the gears are made of alloy steel, heat-treated to approximately 27 Rockwell "C" before machining.

For lubrication in the gear boxes, low-temperature grease is applied to the gear teeth at assembly. No further lubrication is provided, except at infrequent overhaul periods. The design is arranged so that there is only one gear mesh between the position transmitter Selsyn and the final drive.

The elevation drive is equipped with an overload relief clutch for protection when the guns are run full speed into the limit stops. Although limit switches in the sight cut off motor power, there would be sufficient inertia at high speeds to damage the gearing on overtravel. The clutch is a simple spring loaded disk arrangement set to slip at approximately 1½ times the maximum wind load. No clutch is provided in azimuth, for the turret has unlimited azimuth rotation.

Frame and Chute Assembly

The frame and chute assembly (Fig. 8) provides support for the ammunition cases and the collector and interrupter assembly, with the chute portion serving to collect and guide the empty cases and links from the turret. The frame is attached to the inner turret ring and to the saddle support castings.

Load carried on the frame is in excess of 1,300 lb. when the ammunition cases are fully loaded. The access door in the chute allows the gunner to get at his guns in flight, if necessary. All parts of the frame are formed from aluminum alloy and stainless steel sheet, the latter being used in parts on

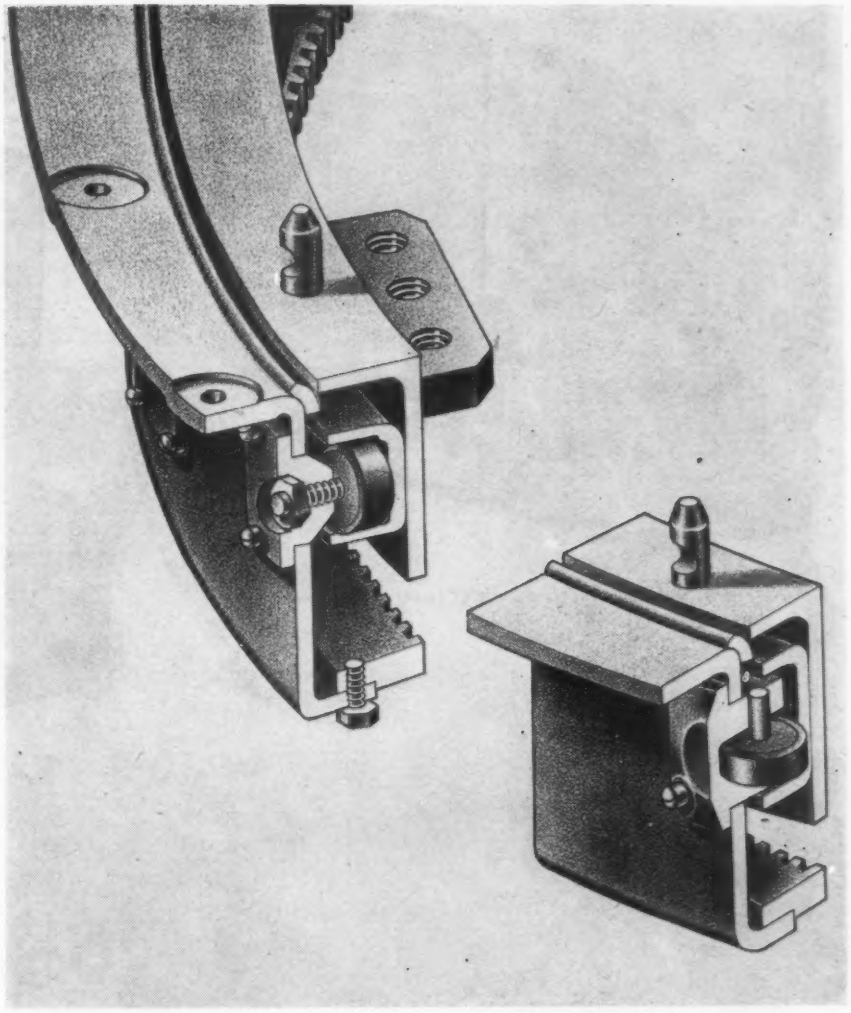


Fig. 4. Details of turret ring assembly.

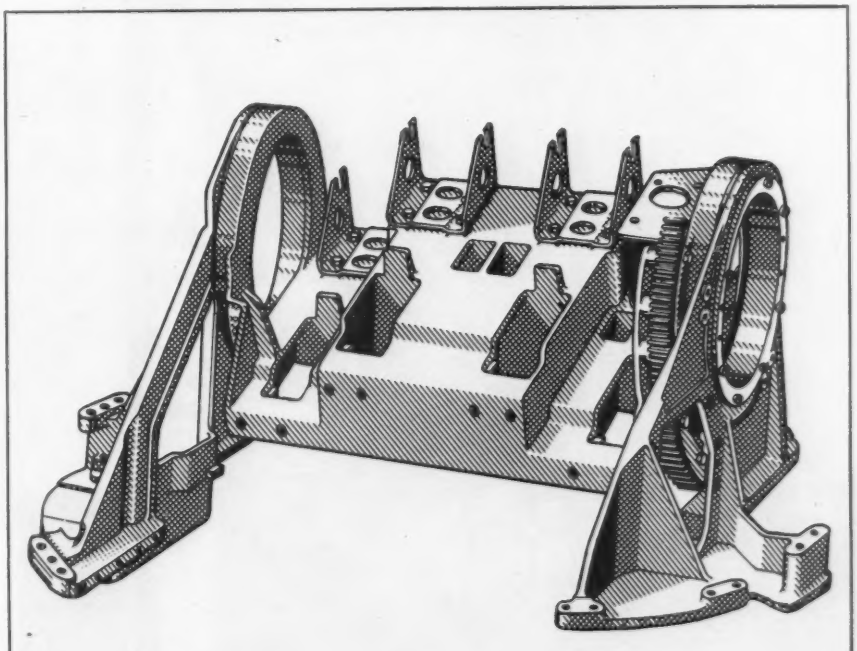


Fig. 5. Saddle and saddle supports for turret.

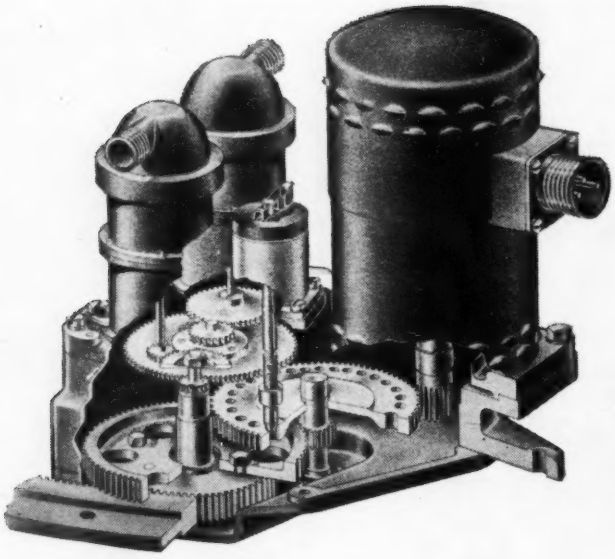


Fig. 6. Cutaway reveals details of turret's drive units.

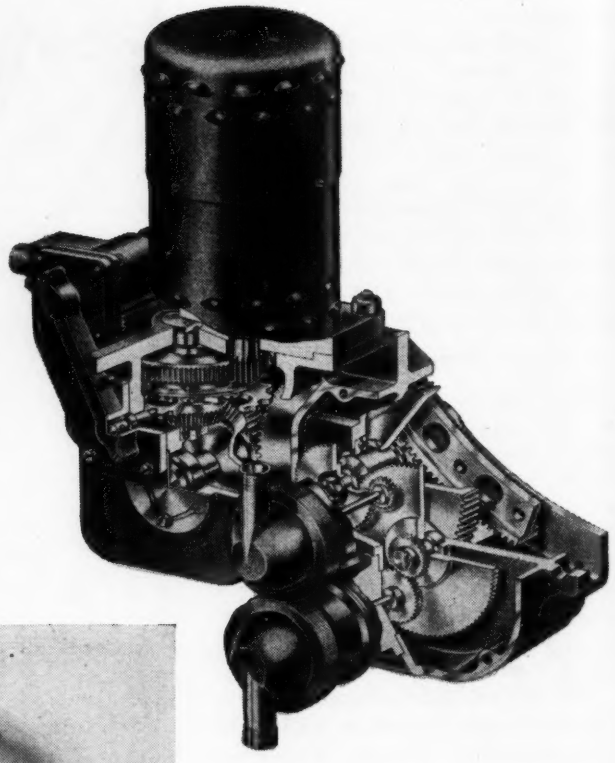


Fig. 7. Further drive unit details.

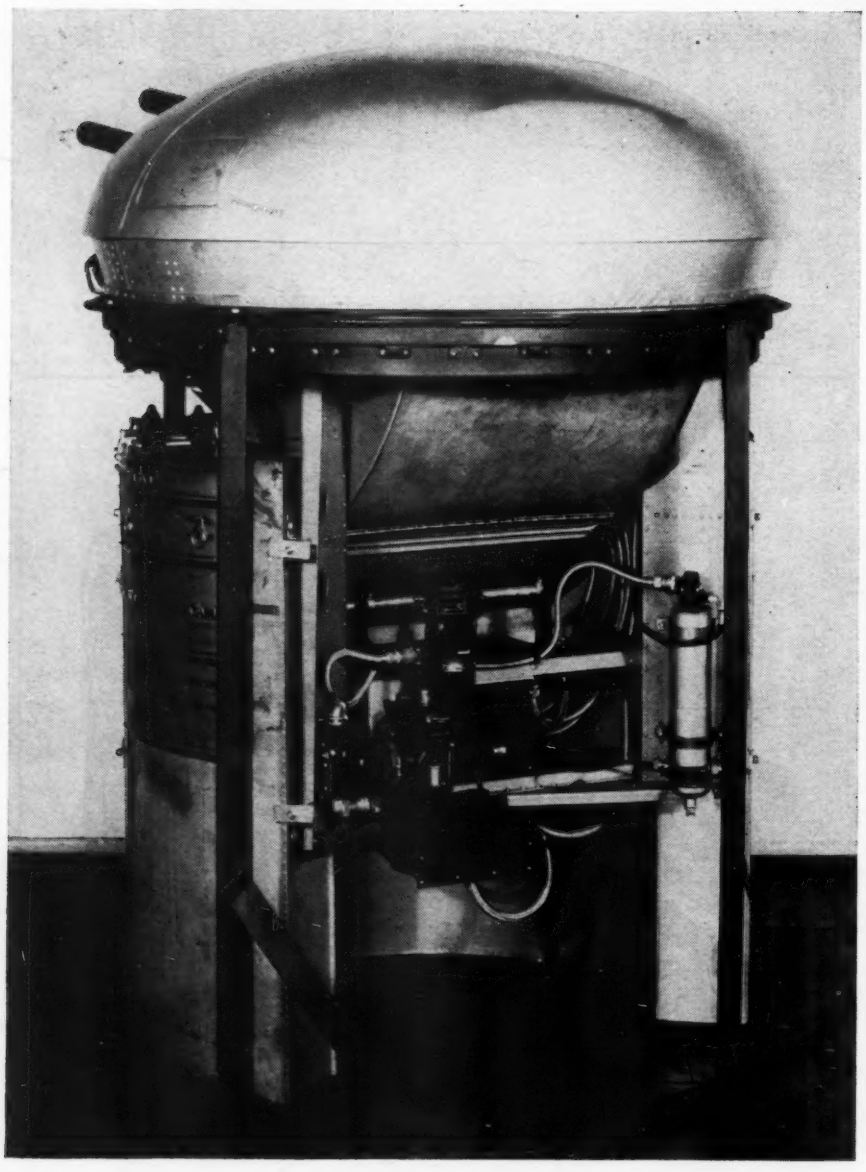


Fig. 8. Rear view of turret exhibits frame and chute assembly.

which ejected cases and links fall directly.

Ammunition cases are supported on angle brackets, with upper and lower brackets on the ends of the cases engaging brackets on wings of the frame to prevent movement either up or down. Clamps hold the cases in place against rubber bumpers around the cylindrical frame. Ammunition cases are of spot-welded stainless steel construction; supporting brackets are riveted to the ends of the cases. Top covers are welded in place, ammunition being loaded through the sliding side door. On each side, the ammunition belts feed up parallel from the fore and aft cases near the ammunition booster chutes. In Fig. 9 is shown a cutaway of ammunition feed to two guns of the B-29 four-gun turret.

Ammunition Booster

A double ammunition booster unit (Fig. 10) is mounted on the outside of each trunnion bearing. On each side, the ammunition belt from the

front case feeds over the lower booster sprocket into the outside gun, and the belt from the aft case feeds over the upper sprocket into the inside gun. Booster gear drives are shown in Fig. 11. Both sprockets are driven from the same motor. Free-wheeling units make it possible to turn the sprockets toward the gun when loading ammunition in the turret, and an anti-reversing latch prevents the ammunition belt from tightening up on the gun when booster power is off.

The booster motor is energized each time the firing trigger is pulled, and booster sprockets are driven at a speed somewhat faster than the rate of fire of the guns. Teeth of the sprocket are made of flexible rubber so that they can slip inside the ammunition belt when the belt becomes slack at the gun. Ammunition guides or strippers prevent overfeeding; thus, no switches or controls are required.

●

In Part II, October AVIATION, *Mr. Humphrey will conclude this graphic study of the B-29 four-gun turret with a consideration of the gun charger, compressed air systems, collector assembly, fire interrupter unit, and means of turret installation.*

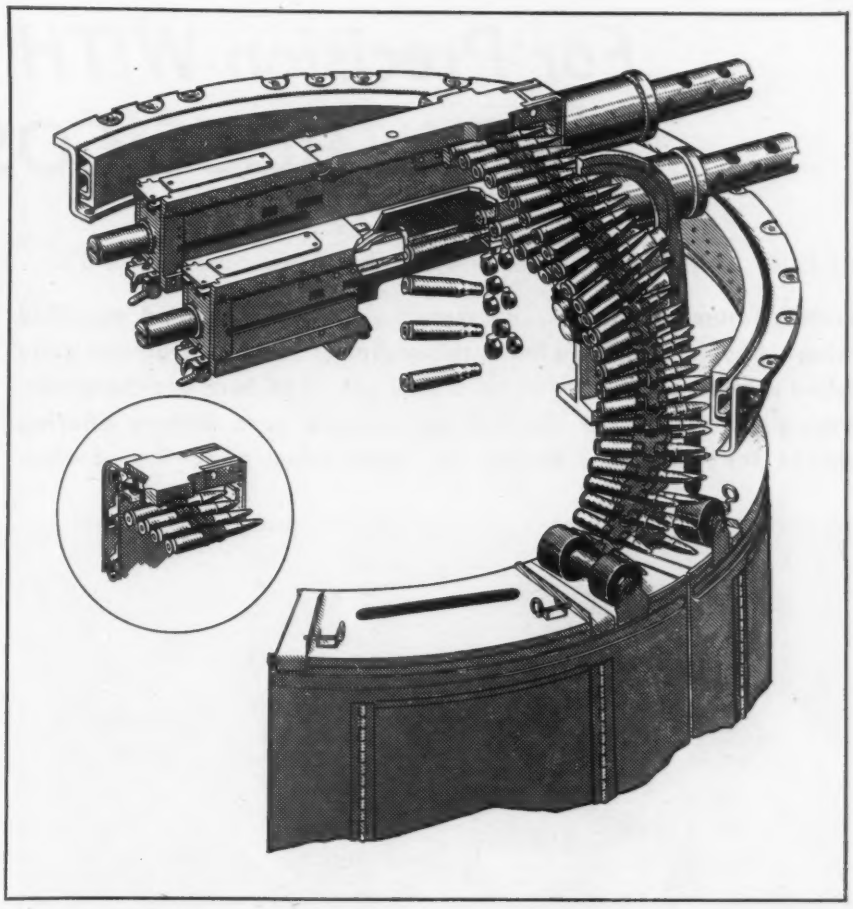


Fig. 9. Ammunition feed to two guns of four-gun turret is illustrated by cutaway sketch.

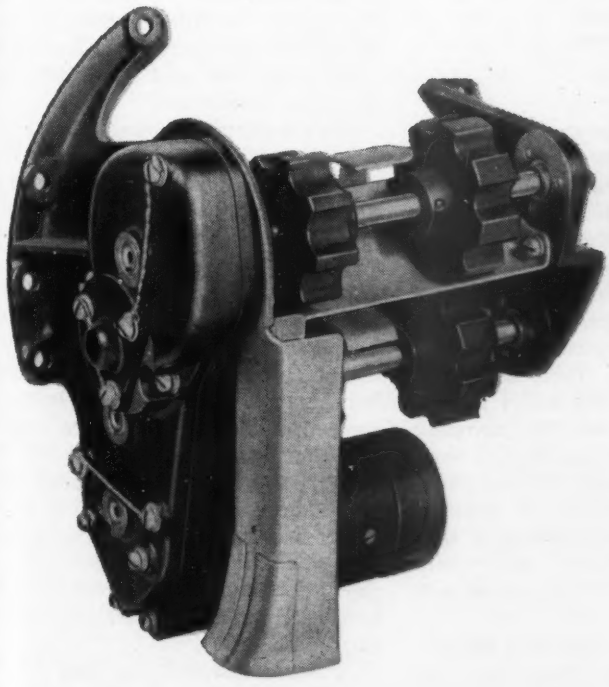


Fig. 10. Photo of double ammunition booster unit.

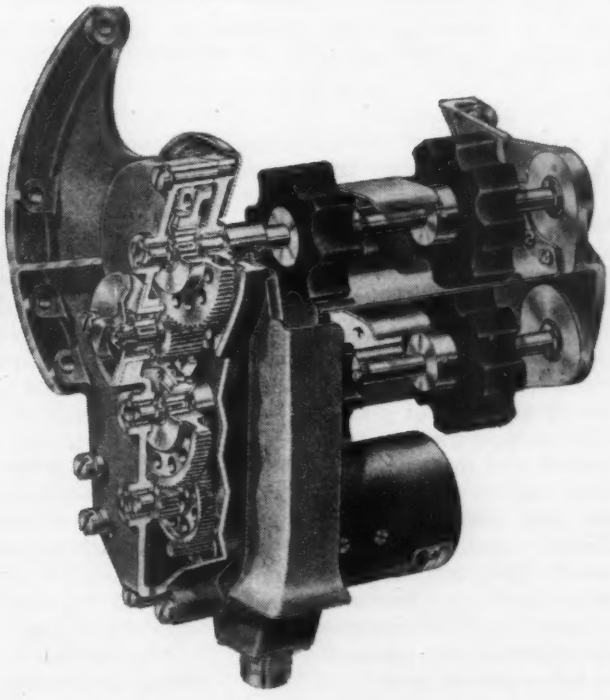
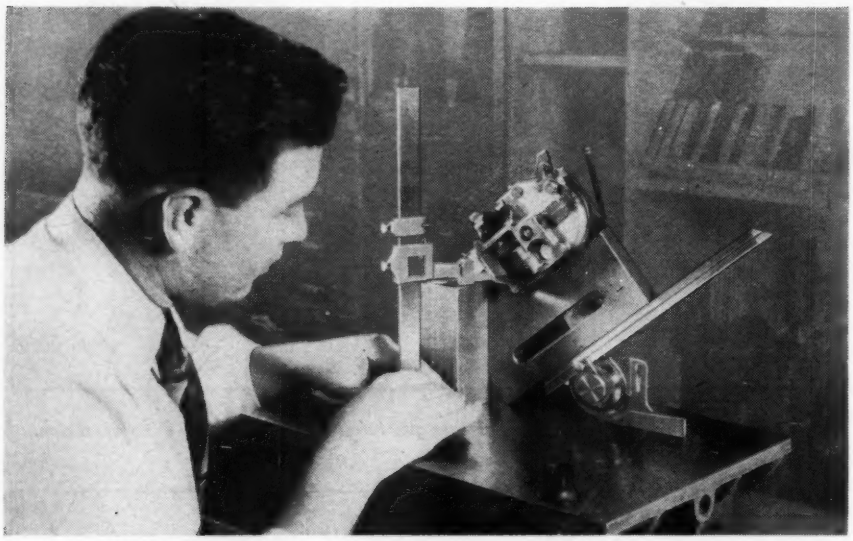


Fig. 11. Cutaway shows inner details of ammunition booster.

For Precision WITH Profit KEY THOSE COSTS

By E. B. SARREALS, *Industrial Analyst, Kollsman Instrument Div. of Square D Co.*

Profit-consuming factors—of wartime procurement and unskilled labor—having come to a head, this maker of aircraft precision units found it imperative to contrive a way out. And here are the profit-saving measures that showed the way—a case history offering checks for companies facing the competitive peacetime period.



Dimensional control is depicted here, with inspector checking incoming die casting for conformance to specifications.

WITH AVIATION ENTERING the competitive phase of manufacture and distribution in the stringent economic period naturally following cessation of war, only those units of the industry which are able to reduce production costs to a minimum while maintaining standards of precision will survive. Hence, to insure methods of economy, a re-examination of the costs of precision production is imperative.

Possibility of reducing costs and increasing efficiency of production processes and controls motivated the Kollsman Instrument Div. of the Square D Co. to analyze its production systems—originally instituted when the demand for flight instruments was relatively small and production costs were below present level.

Material Analysis

Since it is axiomatic that the reduction of material-waste usually presents the greatest opportunity for economy in manufacturing (because such waste represents losses not only in material but also in man-hours used for processing), its elimination became the initial objective of study.

The subsequent survey revealed that deviations in the alloy components of raw materials furnished under wartime conditions of procurement caused a rise in production costs. These deviations were the result of differences in machinability, along with the necessity for variation in type and time of seasoning and exercising. Throughout the production process, the required identification and segregation of each lot, no matter how small, also greatly increased the cost of inspection and material handling.

This condition is illustrated by government restrictions permitting only small lots on hand, wherein one shipment of 5 sizes of rod stock, may prove, upon analysis, to have come from as many as 25 melts of steel—each with its own characteristics, and tending to diversely affect instrument calibration and performance.

Moreover, our company engineers found that the poor quality of available aluminum castings and phosphor-bronze diaphragm material introduced new problems (in research in production methods) to offset possible deleterious effects on performance of precision instruments.

Care in Seasoning

To cite an example, baroswitches and radiosonde frames must be seasoned at low temperatures—usually from −100 to −120 deg. F.—but with the divergent character of metals furnished, it became necessary to try each lot separately to determine which temperatures gave best seasoning results for each. It was also necessary to determine which lots should be baked following the deep freeze, at what temperature, and whether one long exposure or a number of shorter periods would give the best results.

The effect of heterogeneity is further emphasized when it is considered that shifting by as little as .0001 in. in a casting or diaphragm may lead to inexact calibration and consequent failure of an instrument.

Also, the survey showed that a slight change in quality of materials—such as beryllium copper—now available on the market increased the cost of calibrating sensitive altimeters. Altimeter diaphragms were formerly compensated to give identical sea level indications either at room or extremely cold temperatures. With no change in manufacturing procedures or assembly, but because of variance in material, compensation variances were experienced at low temperatures at altitudes from 20,000 to 50,000 ft. Since each such change in material quality necessitates major engineering investigation and retraining of personnel units to meet the condition, the cost of using such heteromorphic material is apparent.

It was discovered, too, that divergence in dimensions and forms of raw materials increased the time required for set-up and machining (necessitating adjustments in time schedules and cost) thus increasing fabricating cost.

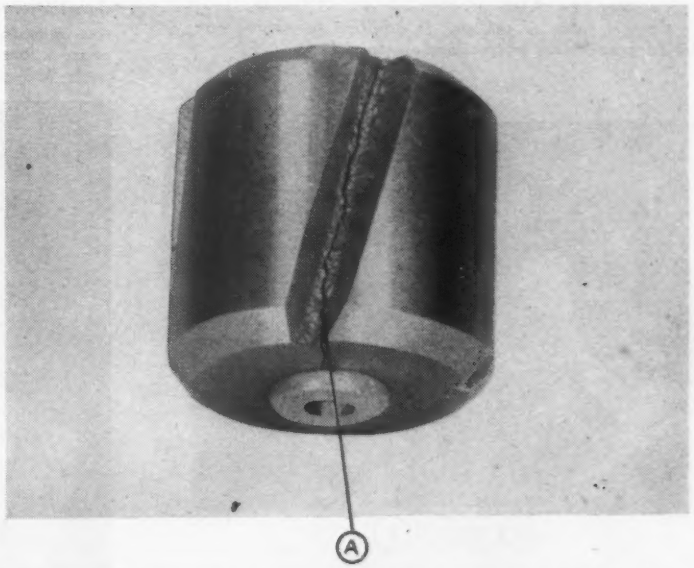
To correct these conditions, the following steps were taken: To determine adherence by vendors to material specifications, facilities for sample testing were expanded to make possible more detailed microscopic spectroscopic, chemical, and metallurgical tests of materials furnished. Norms were established for variations to be expected and accepted under wartime procurement, but, in the main, acceptance or rejection was based on the fact that material best suited for precision production of interchangeable parts were specified in the drawings or manufacturing information furnished to vendors.

Purchasing was kept aware of vendors compliance with material specifications by an exchange of information with Inspection. To facilitate this exchange and to furnish indisputable evidence of findings relative to rejected materials, a special photographic index of defective castings, die blankings, or other materials containing flaws, was set up and classified according to type, part number for which the piece was intended, and supplier. In each instance where material was rejected in volume by Inspection for nonconformance to specifications, photographs showing imperfections upon which rejection was based were sent to the vendor with the rejected stock. If such items were critical and delay for the military might ensue, company engineers collaborated, when possible, with the supplier to eliminate the causes for rejection.

It became apparent, however, that materials purchased to commercial tolerances could be employed only if highly skilled inspectors and operators were used to screen those found defective at one of the various fabrication stages, or, to modify production methods in accordance with the variations in material—since the manufacture of precision instruments is completely dependent upon maintenance, within narrow limits, of uniform physical and electrical properties.

And since skilled operators were drawn off at a rapid rate by the military, and purchased materials were not being held to specified tolerances, it became necessary to revise equipment and processes.

Because diaphragm material offered the greatest problem, automatic inspection equipment was designed and constructed to measure and to record the thickness of such material in continuous rolls. Whenever it is beyond thickness tolerance, the material is automatically marked and since it may vary throughout the entire length and breadth, the equipment explores the entire area—with an accuracy .0001 in.



UNSATISFACTORY CONDITIONS	INSPECTION PROCEDURE	INSP. TIME	MANUFACTURER
(A) Defective casting	1		
	2		
	3		SCALE 2:1 APPROX. DATE 12/29/44
	4		
	5		
	6		NAME MAGNET
	7		
	8		
	9		MATERIAL 377G-3C.1
	10		
	11		
	12		NUMBER 551G-3
	13		
	14		
	15		

Quality control is illustrated in this photographic index of flaws in vendor-furnished material.

The development of inspection and analysis equipment and the re-design of special production equipment, has made possible the utilization of over 80% of materials formerly rejected as unusable, without sacrificing accuracy in performance.

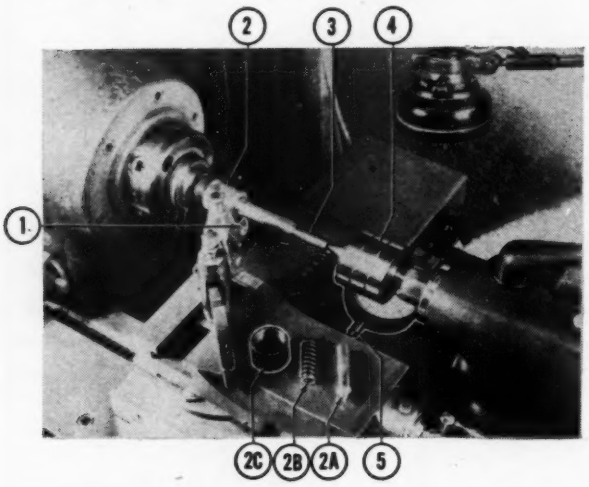
In the fabrication of electric tachometers variation in strength of alnico magnets, in electrical conductivity of manganese copper, and in torque of phosphor-bronze hairsprings were measured and controlled by developing special devices. Tachometers must operate efficiently at temperature extremes, and compensation is achieved by balancing physical property changes of the various parts against the temperature-responsive magnetic material. Since it is not possible to control the properties of the thermo-metal, and because standard commercial methods of metallurgical and chemical analyses and physical measurement failed to yield satisfactory indication of minute differences, electronic measuring devices were developed. These permitted the modification of manufacturing procedure and the utilization of commercial thermo-metal.

The electronic equipment consists of an a.c. conductivity bridge, several testers for magnetic field intensity and distribution, and a magnetic conductivity tester particularly efficacious in revealing porosity in cast alnico magnets *before machining,* thereby saving many production hours previously lost completing machine operations before defects were discovered.

Further investigation revealed that changes in the constituents of lubricants furnished caused failures of instruments—particularly those subjected to high temperatures at take-off and to low temperatures in flight. A suitable lubricant was developed and loss due to this cause was eradicated.

Precision flight instruments are jeweled for accuracy but, because of the scarcity of jewels under war conditions, phosphor-bronze bushings were substituted. These, however, failed to give equivalent longevity. Hence, a plant was built to process available jewel blanks. To achieve economy and efficiency in jewel fabrication, Swiss machinery was redesigned and controls so altered that less skilled labor could produce precision jewels to specification. A new type of jewel, deviating from conventional contours, designed by company engineers, bettered instru-

Seen here is index of set-ups. In addition to photograph, detailed preparation instructions are furnished.



DESCRIPTION: Finish O.D. and face one side between special centers.

PROCEDURE:
(1) Tool ground with .046 flat for width of undercut and 45° angle for chamfering thread and finish turn all diameter except .665 diameter.
(2) Special spring center. Used to stop part against 2C. Center 2A is pushed inside of body under tension spring 2B. Cover 2C has #320 emery glued on face for driving part.
(3) Taper arbor with centers (taper .500 per ft.).
(4) Revolving center.
(5) Indicator used for reading on .4533 $^{+.0000}_{-.0003}$ dia.

Jeweler's lathe, rebuilt with cross-slide and turret having multiple tool mounts, effects economy by eliminating chuckings and tool changes formerly required to complete series of operations on single part. Both slide and turret are removable.

ment performance and effected economy in assembly and calibration.

Operations Analysis

Study of machine operations showed that time losses occurred in making set-ups, because replacements for skilled help entering military service were less proficient. Less skillful operation of machine tools resulted in a higher incidence of breakage of drills, taps, etc., and in more frequent stoppage of machines for realignment of work. Also, necessity for general maintenance of close tolerances in machine operations caused absorption of undue time. And where precision production called for multiple operations to be performed on microscopic parts in jewelers' lathes, multiple chuckings and tool changes caused frequent delays.

Loss of production time stemming from operators' lack of skill in making set-ups was eliminated by special set-up men—workers with greatest aptitude and experience, trained by departmental foremen and made responsible for all set-ups required in their particular machine division. Other operators were required only to maintain set-up. To further expedite and assure uniformity, a photograph of each set-up, together with detailed preparation instructions, was furnished to each division foreman and made available for reference by set-up men.

To facilitate the functioning of preventive inspection, an identical index of set-ups was given to the floor inspectors, increasing their efficiency in eliminating faulty runs resulting from incorrect set-ups. Operators have derived benefit from the index, because the detailed information plus photographs have made it easier to maintain set-ups for production runs. Information relative to speeds and feeds has reduced tool breakage and consequent machine stoppage.

Time loss resulting from multiple chucking of small parts and tool changes on jewelers' lathes was eliminated by redesigning (those lathes used for production runs) to incorporate cross-slides and turrets with multiple tool mounts. This permitted the completion of a series of operations such as boring, reaming, chamfering, etc., with only a single chucking, while tool changes required only a change in turret positioning.

Because general maintenance of close tolerances is an inescapable machining requirement for precision instruments, time losses incurred through inferior skill of war-time operators were offset by redesign of machines and equipment to render, where possible, automatic operation, independent of individual skill.

Methods, Design, Product Engineering, and Inspection collaborated in a study of all specifications—particularly those in which requests for permission for deviation had been made. Where possible, savings in time were effected by widening machine tolerances where this would not detract from quality, and engineering changes were issued so that both operators and inspectors could cooperate in the maintenance of standards.

Functional Analysis of Inspection

Seeking possible reduction in inspection costs the plant-wide service was reviewed. Efforts were centered on improving Inspection's functioning to secure increments in quality rather than impairing its service through drastic reductions in staff or allocations. Believing that properly planned controls can improve efficiency, cut costs, and raise inspection quality, a functional analysis was completed.

Losses, it revealed, were incurred through overstocking of instruments for precision measurement. This occurred because employees made a practice of holding gages in personal tool kits between infrequent uses, forcing excessive purchases to maintain sufficient working reserve.

Also, damage to expensive equipment resulted from improper use, and discounts for quantity purchases were lost because of individual item procurement. Finally, in certain instances brassing and rusting forced the termination of gage life before the full term of use had been realized.

To correct this situation, an order was issued requiring that all gages be returned to the control crib at least

once every 48 hr. This procedure immediately released many gages that had been kept in tool kits and had the further effect of insuring frequent periodic gage inspection.

The problem of rusting of gage surfaces was solved by the use of special lubricants or chrome plating of measuring surfaces to resist damage caused by acids deposited in handling. For thread gages fouled by brassing, special de-brassing baths were devised which afforded restoration to service. Gages below tolerance because of wear were reclaimed by chrome plating and lapping to size.

It was also found that damage to gages caused by improper use resulted from a lack of knowledge of gage care, and an educational program was conducted for foremen, inspectors, and production workers.

A check revealed that delay in transfer of records occurred in securing and returning gages, causing interruption in production while employees waited completion of the transaction. Under the old triplicate slip system, time was consumed initially in making out slips, locating gages, and also upon return—when the files had to be searched for the carbon filed under employee's clock number and the original filed under the gage number.

Gage Control

After consideration of several alternate methods, a control procedure was tested, then adopted. First, all gage drawers were numbered and gage size and type indicated to facilitate speedy location. Next, from existing gage records, all units were segregated by size and type and a control number formulated to identify each gage or measuring device.

Code identification seemed most feasible for this purpose and a simple code was devised. Plain plug gages are designated by "10"; plain plugs with special features are indicated by adding "7" to the type number, forming series "17." To these type numerals, figures indicating size of each gage are joined—a plain plug gage with special features designed to check 0.080 in. carries the number 17-0.080. Serial number of gages within the type and size is added to this stem. Thus, if ten gages, size 0.080 in type 17 are stocked, controlling codes will run 17-0.080-01 to 17-0.080-10.

Thread ring, thread plug gages, and other measuring devices likewise were given specific exclusive numerical designations, and these were stamped on the handles. Moreover, since gages are removed from handles for repair or cleaning, the identifying number was also burned into the gage with an electric pencil to insure permanency.

To facilitate control, gages were registered in a color-coded card index. A white master card for each gage carries the complete description, control number, type size, class, tolerance, and material. Additional space is provided for the name of the manufacturer, description of special features, and listing of parts checked by the gage.

A blue loan-control card carries the control number and gage location at the top, and provides space for borrower's clock number and signature, also date of issuance and return.

And a salmon-colored location card carries the control number, gage locations, borrower's clock number, but no space for signature. Space for Gage Inspection's records of repair or disposal are also provided on this card.

The three cards for each gage—master, loan, and location cards—are placed in sets, in numerical order, in a tub file, with numerical guides inserted every 21 cards to assure ease of use. The last file space to the right in the tub file is used as an "out" file and is provided with sections for inspection and production departments. To maintain time control, each departmental space is subdivided by guides for each day of the week, and thus, all gages subject to recall are automatically grouped for a given day.

When a gage is requested, its size and type are specified. This automatically indicates the control number of the gage. The blue and salmon cards for the gage requested are removed from the file and the gage is drawn from its location. The employee signs the blue loan card, the withdrawal date is stamped, and the card is filed under his clock number. The salmon-colored location card is placed in the out file in the division for the department in which the employee works and under the day of the week on which withdrawal is made.

No delay is entailed in returning gages. An employee gives his clock number and control number of the borrowed gage. The blue loan control card is removed from the clock number file, stamped with the return date, and refiled with the master card.

The location card is withdrawn from the departmental division of the out file, the date of return is stamped, and the card is moved with the gage to the gage inspectors.

If the gage is in good condition, the inspector initials the location card and stamps the date of the gage's return to service, under the proper caption. The card is returned to file behind the master card and the gage is returned to storage.

Should the gage require lapping, debrassing, plating or other repair, the name of the vendor or department rendering this service is entered on the location card which is then placed in the out file under "Repair" until the gage is returned. This completes the routine.

Since a periodic survey of the location cards reveals the frequency of individual gage use by specific type, it is possible to predict probable gage life with reasonable accuracy and to determine future needs for reserve and replacement. This permits quantity purchases rather than spot replacements, with consequent saving through quantity discounts.

The entire system is simple to install. No special equipment other than a multi-wheel hand stamp for numbering cards and a librarian's pencil-top date stamp for registering dates of issue and return is needed.

A set of loan and location cards will last for a minimum of three months, and to prepare card replacements it is necessary only to stamp the index number of the old card on the new. The master card is never replaced, remaining active for the life of the gage. System installation was made without interruption of service.

This system has proved economical in time and cost aspects as well as effective in control. The amount saved directly by its use far exceeds the small cost of initial installation, and the indirect savings have been much greater because a smaller number of gages thereby served increased demands and necessary replacements were fewer than formerly required (when a larger number of gages received relatively little use through improper distribution and control).

Some of the methods discussed have had particular application only to the manufacture of precision flight-control instruments, but problems of material conservation and control, reduction of production costs, and improvement of quality are those of the entire aviation industry. Peacetime changes will see the return of skilled labor and procurement problems will be less, but vigilance will continue to be the price of quality and economy.

The economic future of any unit of the industry is not assured unless its methods and controls have been subject to recent review—regardless of efficiency at installation. While jet propulsion, rotary wing design and engine improvements advance the technology of flight, it must be remembered that only properly planned methods and controls will improve production efficiency and raise product quality so that operation with profit is assured.

. . . Toward Better COMBINATION CONTROLS

By J. W. KELLY, *Chief Engineer, Adel Precision Products Corp.*

Aim of the company engineers was production of controls combining the best features of mechanical, electrical, and hydraulic systems. This called for planned development, and here are the successive achievements which marked the drive toward that goal.

COMPETITION between mechanical, hydraulic, and electrical mode of actuation for various aircraft units has produced results that would probably not have been otherwise attained.

Consequently, after maximum efficiency with minimum weight had been separately achieved with each mode of actuation it became obvious that combinations of the mechanical, hydraulic, and electrical systems, utilizing the best features of each, would afford performance not yet realized.

Recognizing this condition, Adel Precision Products Corp. undertook a program of developing of hydraulic-electrical combinations (termed Hydronic controls) and various mechanical-hydraulic combinations.

First of the electrical-hydraulic combination units to be developed were the solenoid-operated selector valves. Available solenoids were thoroughly investigated for possible standard units usable to operate selector valves, but none were found that came within weight expectations. Accordingly a series of solenoids were developed and test results set up the general type of solenoid to be used for valve actuation. One of the first units put into production had a weight of 21 oz. and gave a pull of 60 lb. over a stroke of $\frac{1}{8}$ in. at 18v. This solenoid was designed for intermittent operation and would reach a maximum temperature of 250 deg. F. after several hours of continuous operation.

Attempts were then made to further reduce the weight, and finally, a double coil arrangement having a primary and a secondary coil was designed. When

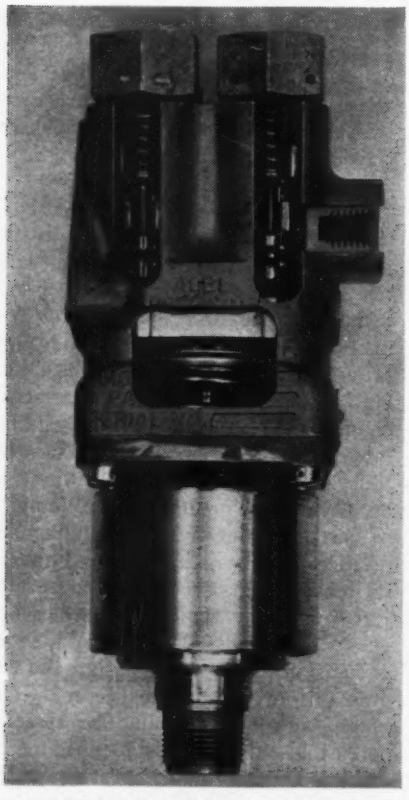


Fig. 1. Adel's first solenoid valve. Unit requires no neutral position and uses rocker arm.

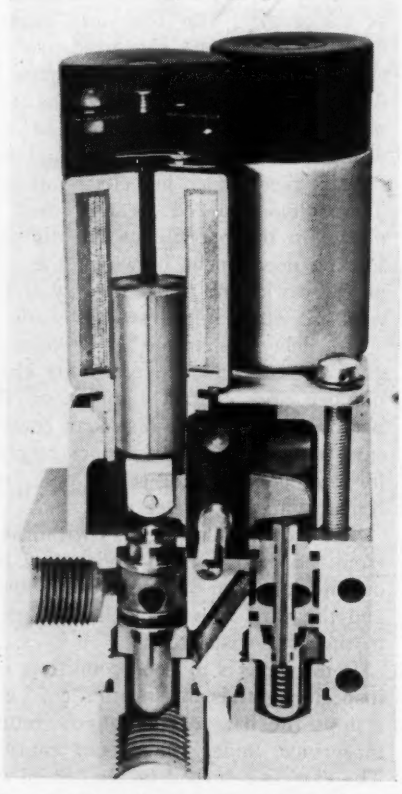


Fig. 2. Solenoid-operated selector valve incorporating rocker arm. Unit requires a neutral position.

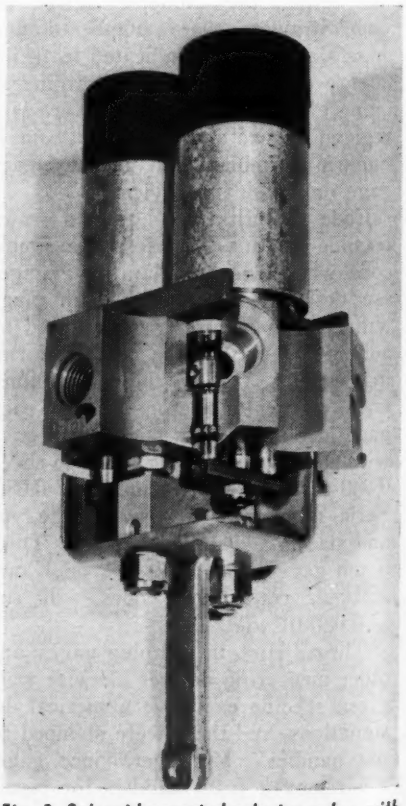


Fig. 3. Solenoid-operated selector valve, with cross bar installation used to replace the rocker arm.

the solenoid is first energized, both coils contribute to the pull. The plunger, upon reaching the end of the stroke, operates a switch, interrupting the current to the primary coil, allowing the secondary coil to apply a holding pull. Thus, an instantaneous high amperage input operates the valve; and the secondary coil, with low amperage input, utilizing the principle that pull increases inversely to the air gap, holds the valve in the desired position. This type of solenoid affords exceedingly high pull with minimum weight.

Having developed a suitable solenoid, a valve had to be designed to utilize the high pull and short stroke characteristics of the unit. Fig. 1 depicts one of the company's first solenoid valves. It requires no neutral position, and uses a rocker arm. A 30-lb. spring loads the rocker arm in one direction, the solenoid pulls 60 lb., and thus 30 lb. is available in both directions.

Another type of valve (Fig. 2), has a rocker arm operated by dual solenoids. This unit requires a neutral position, hence, two of the double coil solenoids are utilized, one being energized for each position. When neither coil is energized, the valve is in neutral. An emergency over-ride lever is added to allow for mechanical actuation in event of electrical failure.

To simplify design and reduce overall cost and weight, a third type of actuation was developed which eliminated the need for a rocker arm. Because of the pressure and return poppet arrangement, it is possible to obtain 4-way valve action by lifting two adjacent poppets at once. Thus, as shown in Fig. 3, a cross bar is put between these two adjacent poppets, with the solenoid pulling on the cross bar. In this design, manual actuation is easily provided.

Various types of valves, including the shut-off, 3-way, and 4-way units, have been designed for solenoid actuation, having single solenoids utilizing spring returns, or double solenoids with and without rocker arms. Operating pressures are 1,500 psi., and on some are as high as 3,000 psi.

Motor-Actuated Valves

The advent of small inexpensive electric motors allows motor-operated valves to become competitive with solenoid-operated valves. Although cost of the motor-operated valve is now slightly higher, proper production engineering may give either the cost advantage. Over and above cost considerations, performance requirements may dictate the use of the motor-operated valve or solenoid-operated unit, since both have advantageous characteristics for particular applications.

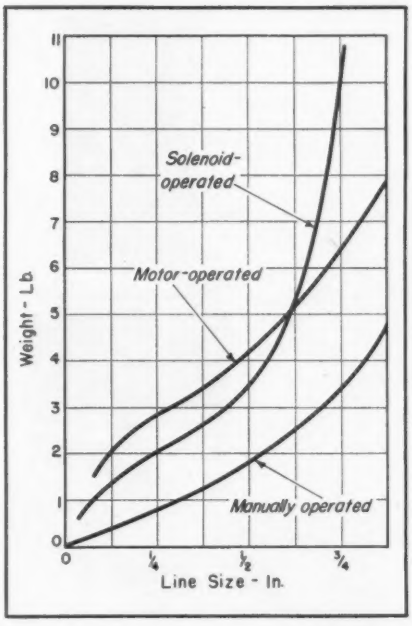


Fig. 4. Graph of relative weights of manual, solenoid, and motor-operated 4-way selector valves.

Solenoid valves have the advantage of conventional selector valves, requiring a neutral position, whereas limit switches are required for motor-operated valves to have a neutral position. However, this advantage is lost with valves requiring no neutral position.

Emergency manual over-ride is easier to obtain on the solenoid because of the free movement allowed in a solenoid when not energized. A manual over-ride of a motor valve leads to complications in design. Solenoid valves have the advantage where fast actuation is required, operating in a fraction of a second, whereas the time for motor valves is usually measured in seconds. However, this applies to direct connected conventional poppet design solenoid valves and not to pilot-operated valves, which are inclined to be somewhat slow and erratic in operation.

Extremely high starting loads, usually found in the larger valves, are handled more effectively by motors which will give out high initial torque as compared with the low initial torque of a solenoid.

Also, a motor-operated valve can be readily designed to stay in either extreme position without being energized, whereas a solenoid requires continuous energizing to hold its position unless locking mechanism is provided.

As shown in the weight-comparison graph of Fig. 4, solenoid valves are lighter than motor valves in the smaller sizes, the curves crossing slightly above the ½-in. line size. Above ½-in. line size, the motor valves have definite weight advantages.

Power Package

The power package—a combination of electrical and hydraulic units—has provided the industry with another unit of extreme versatility combined with weight-saving. Some time ago, when there was a need for an actuator required to hold the valve in extreme positions for a prolonged period, the device shown in Fig. 5 was developed. An electrical-mechanical actuator, originally considered, presented overheating problems when held in a stalled position. By utilizing a small electrically driven gear pump, taking fluid from the return side of the valve, a simple reversible pump and cylinder combination was devised, providing easy actuation of the valve and minimum weight. Because of built-in leakage in the gear pump and cylinder, no over-heating problems were encountered.

This device led to the development of a power package (Fig. 6) for actuation of landing gears and flaps for light aircraft. The unit includes a

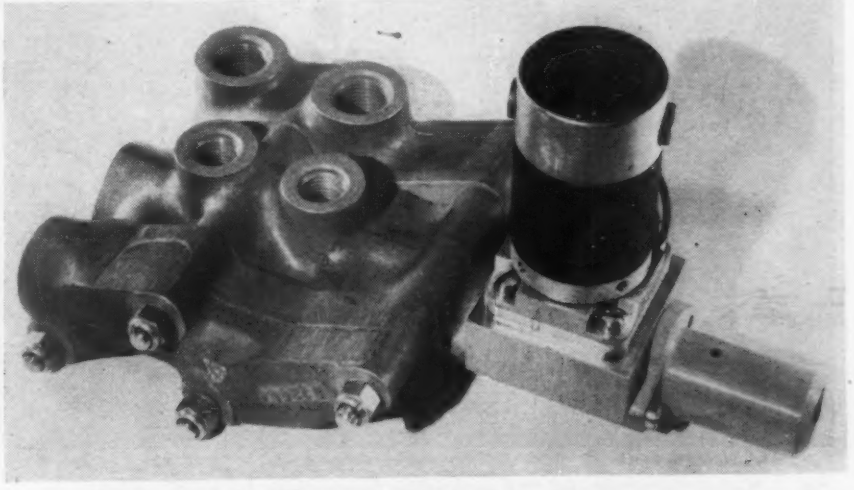


Fig. 5. Early electrical-hydraulic actuator.

motor-driven gear pump submerged in the hydraulic reservoir—a glass tube permitting visual inspection. An integral selector valve allows positioning, a by-pass valve avoids possibility of the reservoir overflowing, and a built-in relief valve provides adequate thermal protection. The device, weighing 4¾ lb., dry, has an output of ½ gpm. at an operating pressure of 300 psi.

Later requirements for a heavier-duty unit dictated a slightly sturdier design. This unit, designed primarily for emergency power stand-by, incorporates a motor, pump, reservoir, relief valve, and pressure and return ports. The glass reservoir is replaced by a casting—fluid level being easily determined with a dip stick. Provision is made for the adaptation of the Adel "Stacking Midget," and thus a package unit can be obtained incorporating a motor, pump, reservoir, relief valve, auxiliary pressure and return ports, and one or more selector valves. The unit gives 800 psi. output at .7 gpm., with ¼ gal. capacity for 11 lb. dry weight.

A somewhat different problem led to the development of the pump and tank combination, shown in Fig. 7, which forms the basis of a power package. Difficulties in pumping oil at 35,000 to 40,000 ft. prompted the design of the pump which shows no cavitation effects at high altitude under high or low temperature conditions. The unit

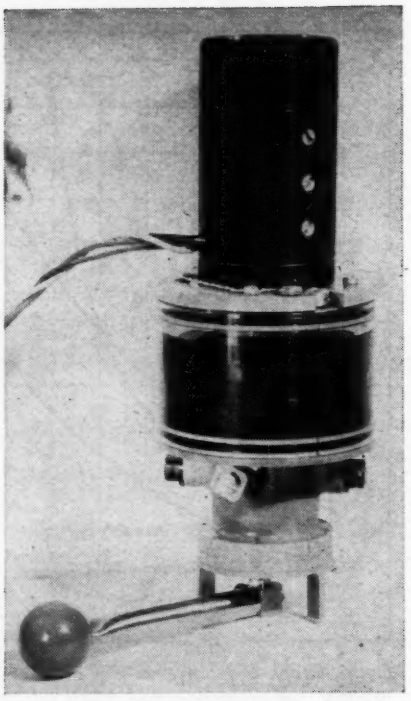


Fig. 6. Power package having motor-driven gear pump (submerged in glass reservoir) and integral selector valve. Output is ½ gpm. at 300 psi.

includes the pump, motor, reservoir, built-in relief valve, and selector valve, and other hydraulic components can be added to produce a power package, which, with a weight of 37 lb., gives 6 gpm. at 1,000 psi. In Fig. 8, power package weights are plotted against hydraulic hp. output. It is interesting to note the slope in the hp. ratings below the 1 hp. point.

The need for combination controls is definitely brought out in the field of the power position control. Three different types of follow-up systems utilizing hydraulic power source and allowing efficient power position control, will be discussed.

Mechanical Follow-Up

Fig. 9 shows a schematic diagram of a mechanical follow-up system applied to hydraulic 4-way valves. Our company has developed several planetary gear follow-up systems, but finds that this walking beam system, through sheer simplicity, has much to offer. The walking beam provides a simple follow-up mechanism on a sensitive rocker arm type selector valve. Movement of the master, or control lever, opens the valve to operate the power cylinder, and displacement of the follow-up mechanism shuts off the valve when the piston reaches the desired position. Motoring and hunting and other difficulties usually present in power position controls, are absent.

Hydraulic Follow-Up

Another installation (Fig. 10), the Adel Isodraulic system, has a hydraulic follow-up. Offering advantages in weight-saving, simplicity, and smooth operation, it consists, basically, of three cylinders in parallel—cylinder 1 forming the master unit, cylinder 2 the valve operating unit, and cylinder 3 the follow-up unit—and works on the principle that when the first piston is moved and held, the second is moved, and the third will move an amount equivalent to the first. As the master piston is moved, the second piston operates the 4-way valve, which applies pressure to the proper side of the power cylinder. Movement of the power piston operates the follow-up piston which automatically shuts off the valve when the desired position is reached.

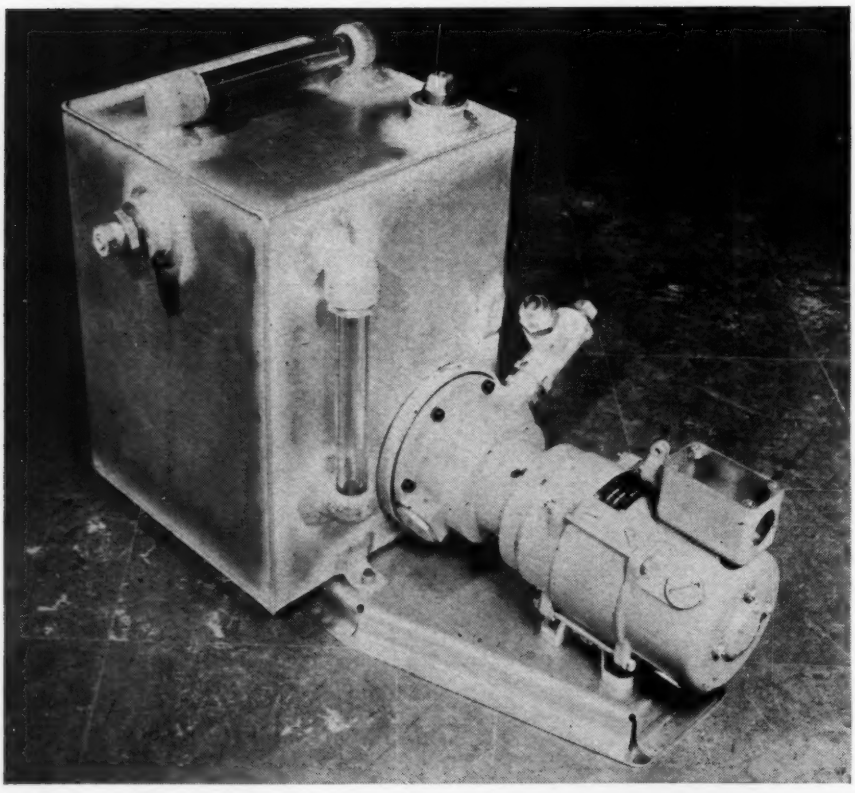


Fig. 7. High-altitude-pump and tank combination forming basis for power package.

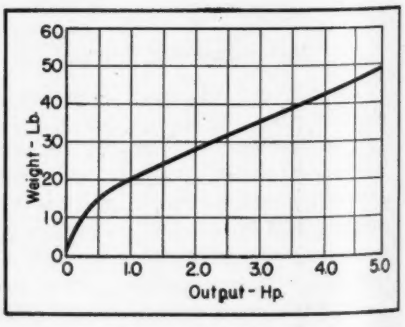


Fig. 8. Weights of electric-hydraulic power packages at various hp.

Electrical Follow-Up

Utilizing the electrical control on hydraulic power, through the medium of a solenoid 4-way valve, another type of power position control combination is presented. Fig. 11 shows a schematic view of a simple electrical (Hydronic) follow-up system. The master potentiometer upsets a bridge relationship with the follow-up potentiometer, and thus, the relay control box actuates the solenoid valve to allow the piston to go to the desired position, at which the follow-up potentiometer shuts off the valve.

As seen in Fig. 12, the Hydronic system, for long distances, is the lightest of the three. Up to about 50 ft., the Isodraulic position control enjoys weight advantages, and below 20 ft. the mechanical system is the lightest.

However, other factors, invariably enter into the follow-up choice. Actual position indication and system "feel" are naturally obtained in the mechanical and Isodraulic systems, whereas no feel is obtainable in the Hydronic system. Long installations are easiest to install with the latter, the Isodraulic coming second, and the mechanical third. The Isodraulic and mechanical follow-up systems being self-contained are not dependent upon any outside source of power for actuation and follow-up, whereas electrical power is required for Hydronic operation. Multiple installations are easier to obtain with electricity, requiring only slight revisions in circuits. For utmost simplicity and comprehension, when servicing in the field, the mechanical system would rate first, Isodraulic second and Hydronic third.

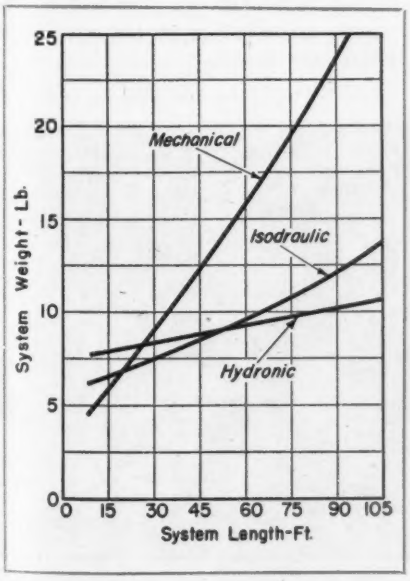


Fig. 12. Graph of relative weights of power position control systems (including master and follow-up controls, power valve, and transmission lines).

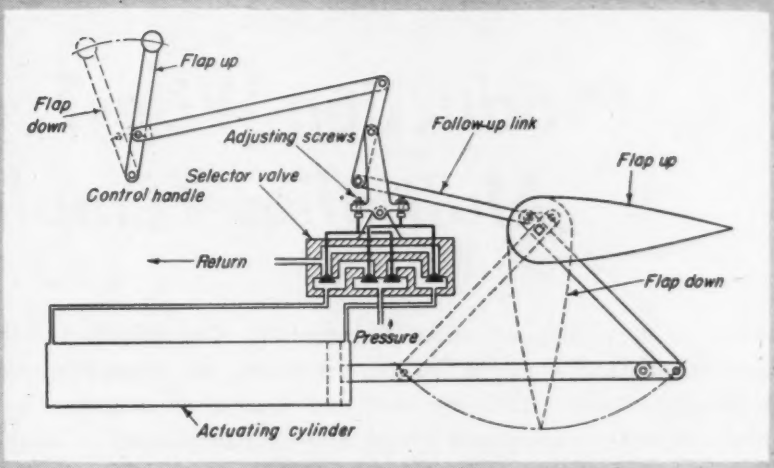


Fig. 9. Schematic diagram of mechanical follow-up system.

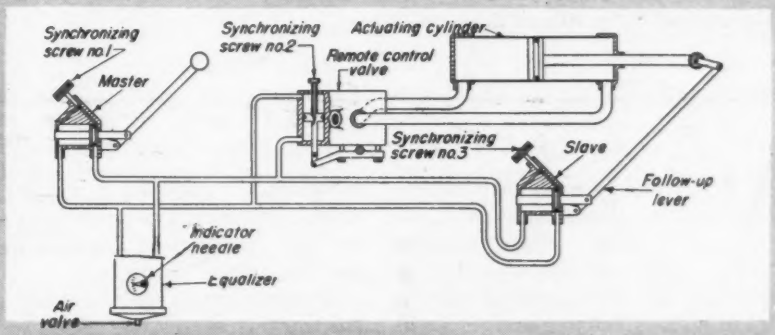


Fig. 10. Schematic diagram of hydraulic (Isodraulic) follow-up system.

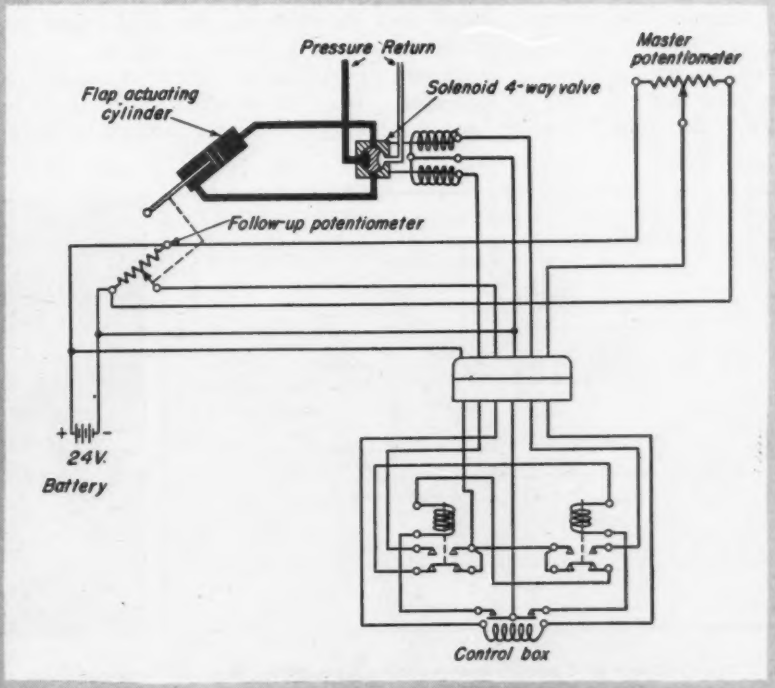


Fig. 11. Schematic diagram of electrical (Hydronic) follow-up system.

Production-Wise Technique Multiplies Template Repro

Planning a new reproduction department, Consolidated Vultee engineers devised a simplified layout based on mass-production experience. Result: Loft masters and templates are now being turned out with new record speed and economy—and in numbers even surpassing the three-fold increase planned.

By C. F. REUPSCH, *Chief of Materials and Processes, and*
R. E. GREEN, *Supervisor of Template Reproduction,*
Consolidated Vultee Aircraft Corp., San Diego

WHEN THE NEW template reproduction department of Convair's San Diego division went into operation early this year, it represented the culmination of several years of intense planning and research.

One of the first problems in laying out the new department was the selection of methods to be used in reproducing the variety of work required by the engineering, tooling, experimental, and template departments. Based on the standpoint of efficiency, durability, versatility, and economy of operation, two basic methods were decided upon —the reflex and the offset proofing processes. In addition, it was decided to add a large camera capable of reducing loft drawings to convenient size for blueprinting purposes.

Arrangement of equipment and various working spaces was aimed so that each was a self-contained unit. At the same time it was desired that a straight line flow of materials should exist, within limitations imposed by the department's location, area, and supporting columns. The final layout decided upon is shown in Fig. 1.

All loft masters enter the department from the entrance shown at the left in Fig. 1 and leave through the light trap seen at right center. Masters 3x5 ft., or less, may be routed to either of the contact printers or to the camera room, while anything larger, up to the maximum size of 5x12 ft., is cared for on the large printer or camera. A monorail system facilitates handling of large metal masters and stock.

Photographic chemicals are brought in from the area-way to a small service elevator, where they are lifted to a mezzanine extending over the developing trays. This enclosed mezzanine serves as a chemical mixing room (Fig. 2), from which solutions are piped to the trays and tanks by gravity lines. All stock enters the department from the area-way and is stored in locations convenient to each of the operating units.

One of the most interesting features of the department is the lighting system, which is not only most convenient but also insures the absolute safety of sensitized photographic materials. All white lights operate from key switches, which makes it impossible for these lights to be turned on by unauthorized personnel. In addition, automatic switches are installed at every doorway so that in case the white lights are on in any of the rooms they will be instantly turned off upon the opening of any of the doors.

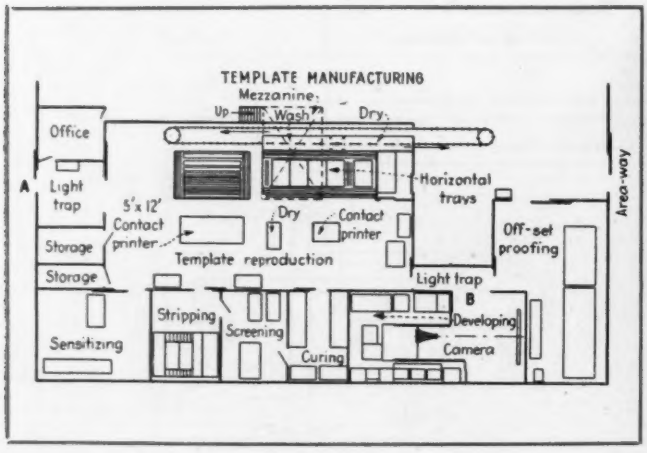


Fig. 1. (Left) Layout of Convair's new template reproduction department shows placement of processing and reproduction units and apparatus. Work comes in through light trap at left (A) and leaves from light trap at right center (B). Fig. 2. (Right) Photographic chemicals are made up into solutions on mezzanine, then are piped directly to developing tanks and trays. A service elevator is used to transport materials to this room which has a convenient shelving arrangement for storage of the chemicals.

Fig. 3. (Left) Cylindrical press is used for transfer of layouts or templates to metal sheets by means of a circular blanket. Press can also make complete symmetrical reproductions from layouts with but half-contours developed. Fig. 4. (Right) These are vertical developing tanks especially designed to handle a large number of big glass plates at one time. Handling of glasses, set in racks, is facilitated by hoist. After glasses have been thoroughly air dried, they are then transferred to the screening room for further treatment.

The offset proofing press is a complete reproduction unit. Tooling layouts or templates to be reproduced are received from the adjoining template manufacturing department. These are placed on the press bed, inked with a hand roller, and the impression is transferred to either bare or white-painted metal by means of a cylindrical blanket (Fig. 3).

Installed originally to make only direct copies, the usefulness of the press has been tremendously increased through division-originated developments. The first of these introduced an especially-prepared intermediate blanket which made possible the production of right-hand or mirror images. This, in turn, led to the making of complete symmetrical reproductions from layouts having but one half of the contours developed to the line of symmetry. These developments have resulted in reducing the production load on the photographic section of the template reproduction department.

Work in the photographic section is based on the large glass negatives used in the reflex method. Vertical tanks and an overhead conveyor makes possible the simultaneous handling of a large number of glasses (Fig. 4). After glasses have been air dried they are transferred to the screening room for the application of adhesive and sensitized paper. The adhesive, which is specially made for this purpose, is applied to the glass by means of a silk screen (Fig. 5).

Following this, the glasses are placed in drying racks (Fig. 6), until the adhesive is quite tacky. The glasses are then returned to the screening table, and sensitized paper is rolled over the adhesive surface, after which the edges are trimmed and the glasses are stacked one on top of the other in the curing room, to remain approximately 24 hr. At the end of this time the negatives are placed in vertical racks along the walls of the curing room where they stand for another 24-48 hr.

Negative glasses are withdrawn from the curing room, as needed, and exposed on either of the two contact printing tables (Fig. 7). Then they are developed in the horizontal developing trays (Fig. 8) and placed on racks to be dried by an overhead warm air blast. After drying, the negatives are returned to one of the contact printing tables and a positive exposure is made on sensitized metal. The negatives may then be held for several days, or they may be sent to the stripping room immediately to again go through the process of cleaning, screening, and curing.

An entirely new method of sensitizing metal, plastics, and wood is used at San Diego to assure a perfectly uni-

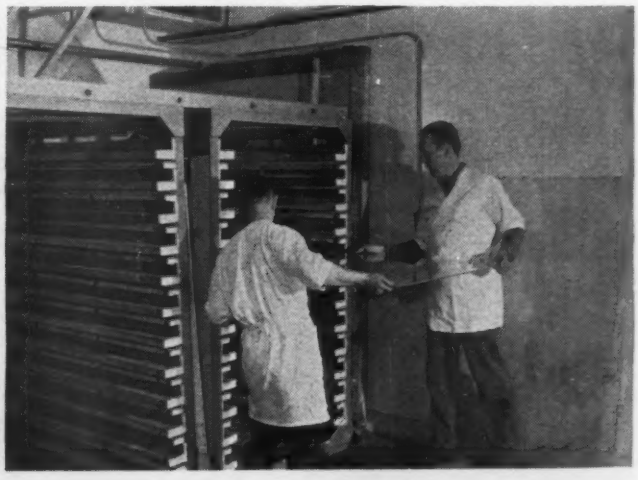


Fig. 5. (Left) Clear glass plates receive a coating of adhesive for transfer of emulsion from sensitized paper to glass. This is done by use of silk screen seen here. Fig. 6. (Right) Following application of adhesive, glasses are placed in these racks until adhesive is tacky. Glasses are then returned to screening table, and sensitized paper is placed over surface. They are then allowed to "cure" for 48-72 hr.

Fig. 7. Withdrawn from curing room, glasses are next placed on contact printing table and exposure made. Convair has two such tables. In left background can be seen racks where developed glasses are dried by warm air.

Fig. 8. After exposure has been made glasses are then developed in these large horizontal developing trays. After development and drying, glasses are returned to printing tables and a positive exposure is made on sensitized metal sheets.

form layer of emulsion. This gives uniform densities in the finished print as well as permitting the sensitization of various materials very quickly. The method used is very similar to the procedure of laying down a decal.

Specially prepared photographically sensitized paper is first immersed in a tray containing diluted isopropyl alcohol. The emulsion side of the paper is then placed in contact with the painted metal, plastic, or wood, and after approximately 1 min. the paper backing is peeled away, leaving the emulsion adhered to the stock. In case of necessity the emulsion can be transferred to the material, dried, and used within 15 min.

Sensitized metal up to 3x5 ft. may be developed in the horizontal trays after exposure, although it is customary to develop both large and small positive plates in stainless steel vertical tanks set in the floor. Special load bars, working from an overhead crane, handle the 5x12 ft. sheets, or the equivalent in smaller sizes, through the developing and fixing tanks (Fig. 9).

The developed plates are then transferred, along with the load bar, to an endless conveyor which carries them through washing and drying cabinets. Upon emerging from the drying cabinet, the finished reproduction is outside the reproduction department and is ready for use in the template manufacturing section.

The camera room is designed for the purpose of making reduced copies on film from which blueprints can be made. The camera, of the horizontal type, was designed and built by the division. Built integrally with the camera is a 5x12 ft. copy board designed to hold metal drafts in position by vacuum (Fig. 10). Special camera backs make it possible to use the apparatus as an enlarger, and micrometric focusing permits making of accurately scaled negatives or reproductions. This camera has also been used in special cases for complete reproduction of loft boards and templates. Surrounding the camera on three sides is a compact darkroom for developing negatives and making small contact prints.

This department was originally designed for approximately a three-fold increase in production over that regularly achieved by the original template reproduction department. For some time now this figure has been greatly exceeded, it not being unusual to turn out 55,000 sq. ft. of template reproductions per month. This output has helped tremendously in facilitating production of B-24 Liberators and B-32's. And plans for new planes are being reproduced daily in this department with a speed and economy formerly believed impossible.

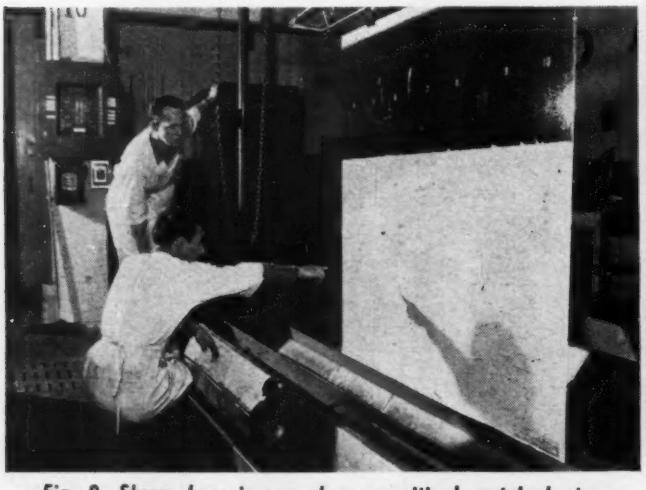


Fig. 9. Shown here is very large sensitized metal sheet after exposure, being carried through developing process by way of special load bars fitted to an overhead crane.

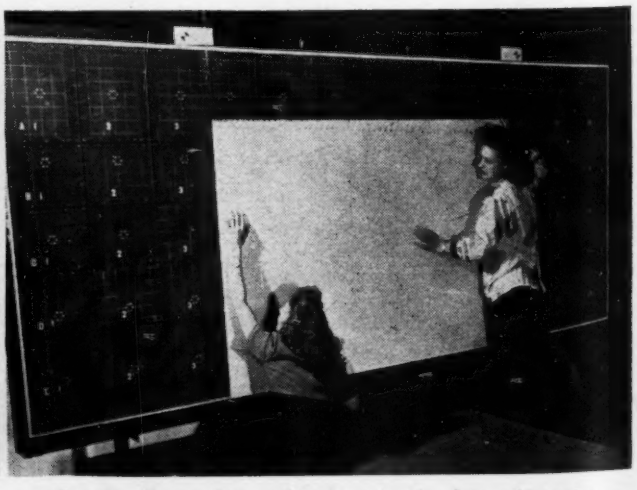
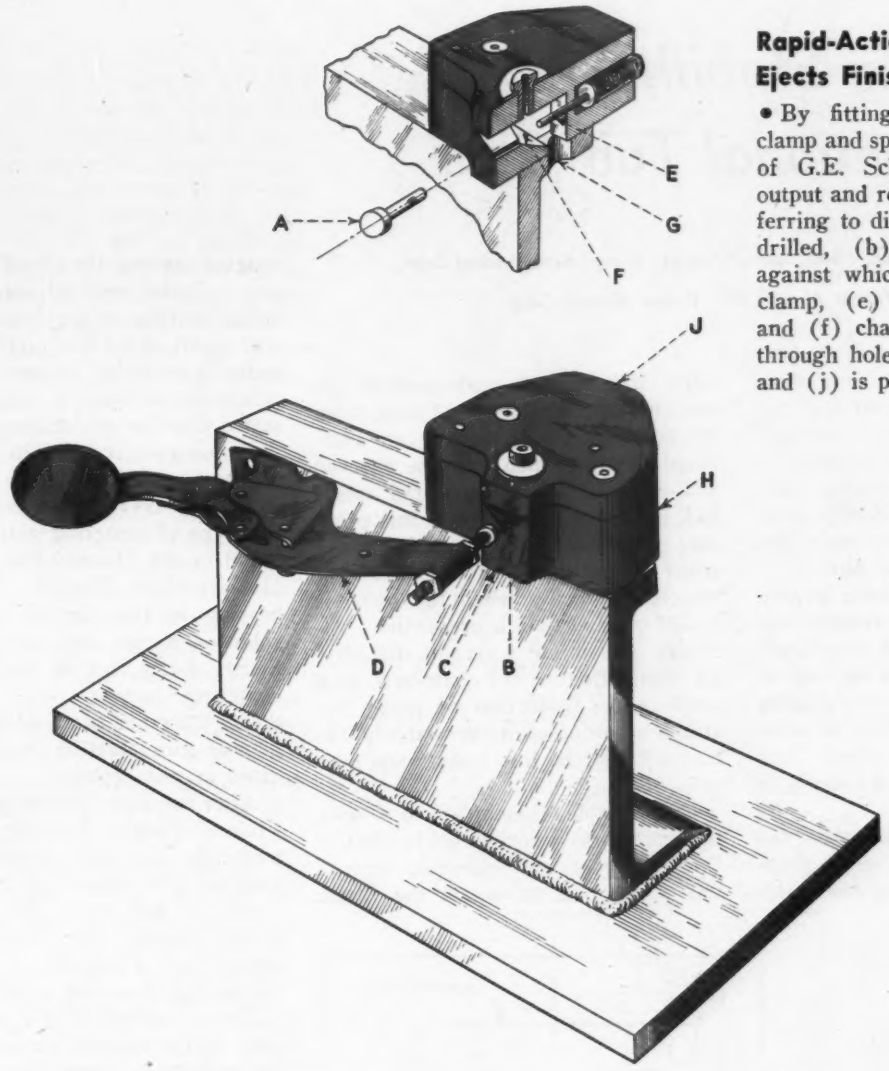


Fig. 10. For making reduced copies on film, this extra large copy board is designed to hold metal drafts in position by vacuum. Copy board is built integrally with camera.

PLANT PRACTICE HIGHLIGHTS



Rapid-Action Jig Ejects Finished Job

• By fitting a V-block with lever clamp and spring ejector, Leo Malecki, of G.E. Schenectady plant, speeded output and reduced drill breakage. Referring to diagram, (a) is work to be drilled, (b) jig, (c) flat surface against which work bears, (d) lever clamp, (e) spring-operated ejector, and (f) chamfer which directs chips through hole (g). V-block is at (h) and (j) is plate-holding drill bushing.

Pre-Set Beading Machine Eliminates Material Waste

• Through use of this beading machine devised by company's plant engineers, Bell Aircraft has improved accuracy of tube beading process and has overcome previous loss of material through overbeading—frequent when hand method was used. Machine has stop to gauge accurately distance of bead from end of tube and adjustable beading roller which turns out identical work indefinitely after it has once been set to required depth.

Putting Taxi Stability Into Conventional Tail Gear

By M. G. SCHERBERG, *Head, Special Projects Group, Aerodynamics Dept., Chance Vought Aircraft Div., United Aircraft Corp.*

DURING TAXIING, the free-swivel wheel of the conventional tail gear renders the airplane directionally unstable, and pilot must constantly use the brakes for directional control. This instability becomes particularly troublesome on windy days and when considerable taxiing must be done.

To avoid this rather tiring experience, pilots will do their straightaway taxiing with the tail wheel locked, and then unlock the wheel for turning or close maneuvering. If only shallow turns are needed, the turn is often forced with the tail wheel locked. This practice leads to accelerated wearing of brakes and tail wheel tire.

In some instances, steerable tail wheels have been introduced to simplify directional control, but the instability still remains and requires the attention of the pilot. And aside from the cost in weight, there is an additional control which must be checked and serviced. The usual tail wheel lock has some free play and this probably contributes to the curved tracking often experienced with locked tail wheels—especially when the plane is taxied or landed in a crosswind. Although this is not a serious difficulty, its elimination would contribute to a much-needed reduction of pilot's required attention—now very thinly distributed between instruments and controls.

One notable attempt to cope with these problems was reported in 1939. A Sports Avian was equipped with a tail wheel unit in which the thrust bearing between the wheel yoke spindle and spindle housing consisted of a roller bearing on a cylindrical cam so that a part of the load on the tail transmitted a centering torque on the wheel whenever it was off center. It was stated that the strong centering action provided good stability in ground runs and taxiing.

And a 1943 report indicated that this type of centering action was also found in the Heinkel He-111 and the Messerschmitt Me-109. The thrust bearing in the Me-109 comprised a roler on a cam such as used in the Sports Avian, but in the He-111 the centering action was transmitted through a set of matched cams. Good ground run stability was also indicated in this report.

After a review of existing literature, Chance Vought Aircraft decided to undertake the experimental development of a matched-cam type of load centering tail wheel for application to the Corsair. The objective was to design a set of cams which could transmit enough centering action to provide positive stability over a considerable part of the taxiing speed range, and be sufficiently stiff directionally to allow safe crosswind landings (even for "green pilots") without locking the tail wheel, but not be too stiff for turns from a standstill or at customary taxi speeds. Also when the tail wheel was off the ground, the cams would be required to center the tail wheel by spring action.

Figs. 1 and 2 show diagrammatically how the cams function. Fig. 1 represents the airplane in a right turn. The force F_B is the ground reaction produced by application of the right brake. This force induces the ground reactions, F_f and F_t, which affect the curved tracking of the airplane. With the usual free-swivel tail wheel, the force F_t is negligible, and F_f—the side force on the front wheels—will wind the airplane into a tightening spiral unless brake is applied on the left front wheel.

Fig. 2 shows the action of the matched cams in this situation. (See,

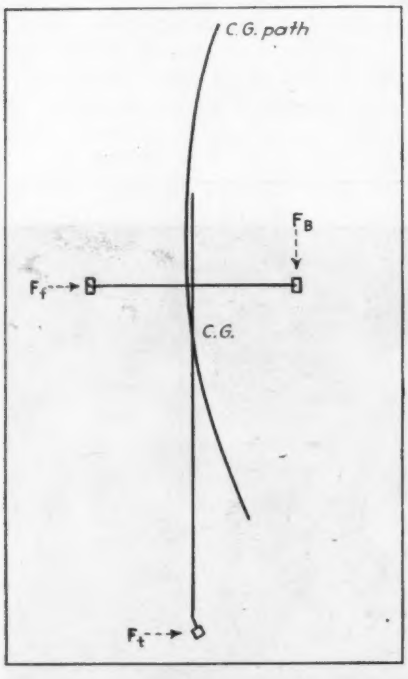


Fig. 1. Diagrammatic representation of airplane in right turn. Force F_B (ground reaction produced by right brake) induces F_f and F_t which affect curved tracking.

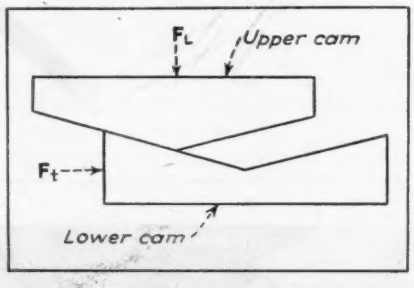


Fig. 2. Action of tail wheel matched cams in situation shown in Fig. 1. F_L is tail load.

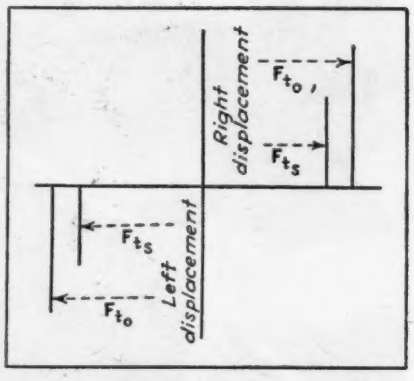
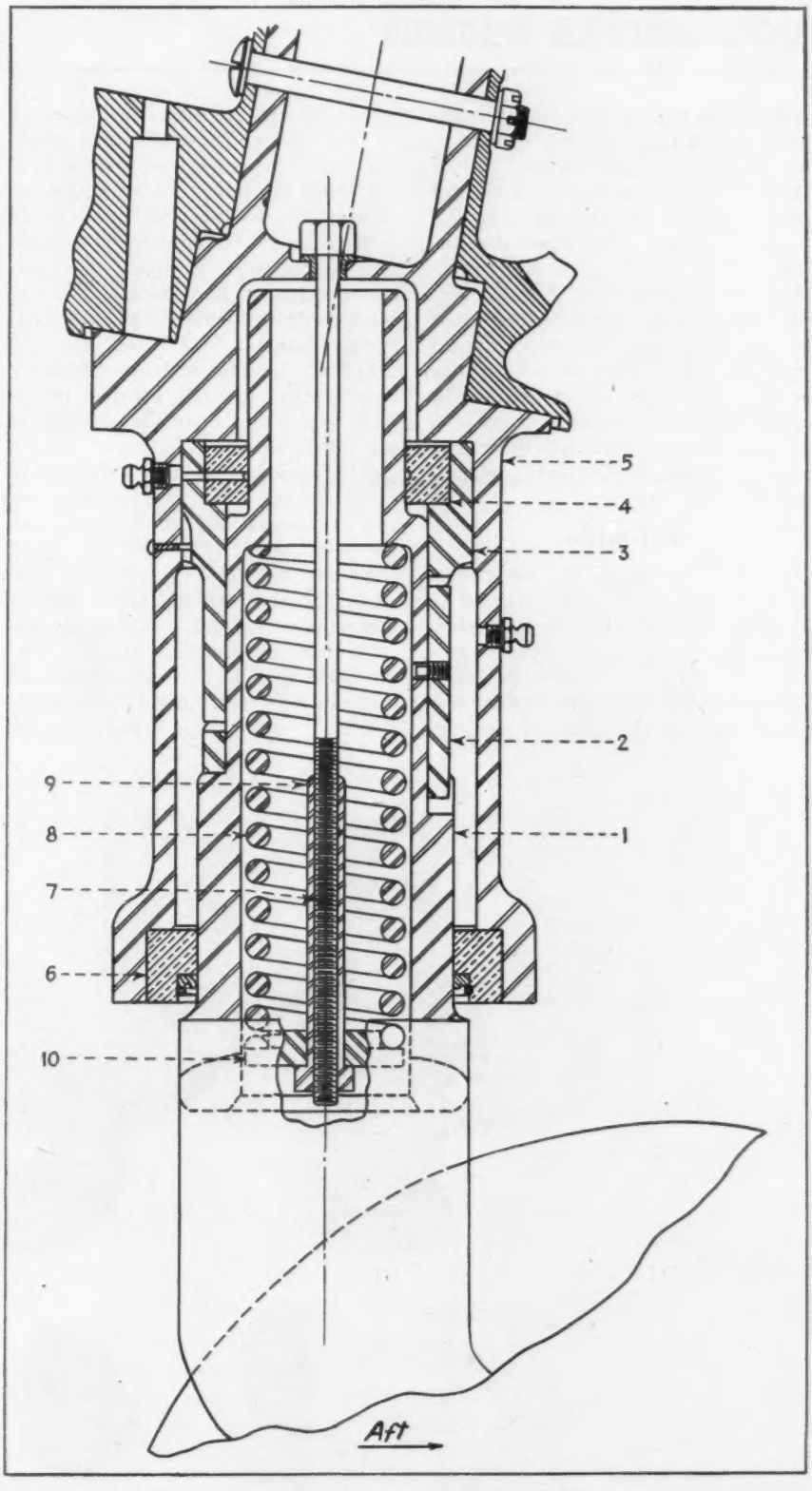


Fig. 3. Force diagram for cam action.

Fig. 4. Sectional view of experimental matched cam type of load centering tail wheel: (1) Spindle yoke, (2) lower cam, (3) upper cam, (4) upper bushing, (5) housing, (6) lower bushing, (7) bolt, (8) spring, (9) sleeve nut, and (10) washer.



also, Fig. 7). The pressure of the upper cam which supports the tail load (F_L) on the lower cam induces the reaction F_t from the ground. By making the cam angle (α_c) large enough, for a given amount of trail of the center of the wheel from the spindle axis, the force F_t will, for the usual taxi speeds and rates of turn, have a higher turning moment about the airplane c.g. than will F_r. Hence, as soon as the brake action is removed, the radius of turn of the airplane c.g. will increase until the plane is tracking on a straight course.

It is clear that the cams will remain in the locked position until the side force F_t has become large enough to slide the lower cam. Once sliding has started, the force F_t will remain constant in magnitude so long as the direction of motion remains unchanged. Because of friction, the constant value will be greater for the opening of the cams than for closing. Thus, because of the friction between the cam surfaces, the side force F_t will have a range of values between two fixed values (F_{t_o} and F_{t_c}) for each of the open positions.

Fig. 3 shows a force diagram for the cam action. The airplane will have: (a) Positive stability when the induced side force at the tail wheel is less than F_t ; (b) neutral stability for side forces between F_{t_o} and F_{t_c}; and (c) negative stability when $F_t \geq F_{t_o}$. Successful application of this very simple device depends to a great extent—as will be shown in the discussion of the test results—on the presence of a suitable lubricant.

Preliminary Design

A Corsair was made available for the tests and basic dimensions were selected so that an adoption of the cam design could be made for the plane with a minimum of design changes. With these basic dimensions and some values of anticipated friction coefficients, it was estimated (after discussions with the experimental pilots) that a 22-deg. cam would be about the steepest acceptable if excessive braking action for turning from a standstill were to be avoided.

Fig. 4 shows a sectional view of the experimental design, and Fig. 5 depicts the component parts labeled to correspond to the sectional drawing. The spindle yoke (1) has lower cam (2) of aluminum-bronze staked in place on the spindle. The upper cam (3) is of case-hardened steel with an aluminum-bronze bushing (4) pressed in place.

The unit is assembled by dropping the upper cam into place in the housing (5), then bolting so that it is fixed relative to the housing. The spindle yoke with the lower bushing (6) in place and with the lower cam staked on, is slipped into the housing and bolt (7) and spring (8) are then slipped into the hollow spindle from the upper and lower ends, respectively. Sleeve nut (9) is slipped through washer (10) and then screwed onto the bolt until the spring is compressed to design pressure. When the space between the housing and the spindle has been filled with suitable lubricant, the unit is ready for installation on the plane.

Fig. 6 shows the positions of the

cams on the yoke-spindle when the airplane is making a landing run or is taxiing on a straight heading. Fig. 7 shows the cam position when the tail wheel plane is approximately 90 deg. to the fuselage axis—when the airplane is in a turn about a pivoting front wheel. And finally Fig. 8 shows the cam positions when the tail wheel has swung through 180 deg. while the craft is being backed up on the line or into the hangar. As can readily be surmised, it was this last position with its high stresses which was difficult to cope with from a structural and performance standpoint.

Test Results

Cams of 10, 14, 16, 18, and 22-deg. were tested. The 22-deg. cam, with so-called "altitude" grease as a lubricant was tried first and proved to provide too positive a lock. The cams would not open when the airplane was towed out of the hangar—the tail wheel skidded sideways during turns.

The 10-deg. cam was then tested and was adequately free for the tow-truck but the jumpy swivel action indicated clearly that the cams would require a special lubricant to obtain desired performance. (An oil-graphite mixture had been used.) The test pilot could not detect noticeable centering action. This cam was not tested for turning stability—tendency to maintain a fixed turning radius with free brake after the airplane is put into a turn.

The 14-deg. cam also gave jumpy swivel action when first installed but this effect was very much reduced as the tests progressed. This cam gave the first favorable results and was tested by several test pilots. Strong centering action did not occur in this case either, but turning stability was very noticeable at the lower speeds and rates of turn. If the turn was slow, the craft was easily straightened by kicking opposite brake, after which it maintained a straight track without further application of the brakes. A tight turn required two kicks on opposite brake to achieve a straight track. Thus, some pilot familiarization with the use of brakes would be necessary to take full advantage of the 14-deg. cam.

The plane was taxied up to relatively high speed (50-60 mph.) with variation of acceleration, and maintained a straight course without the aid of brake or rudder. It held a straight course when taxied in a 30-mph. crosswind with 50-mph. gusts. A ground crew handling-test indicated that the 14-deg. cam would be satisfactory in that respect. It took four men at the tail, instead of the usual three, to open the cams and swing the airplane. One man handled it easily with the use of a tail wheel handling bar, which slips into the hollow tail wheel axle and provides

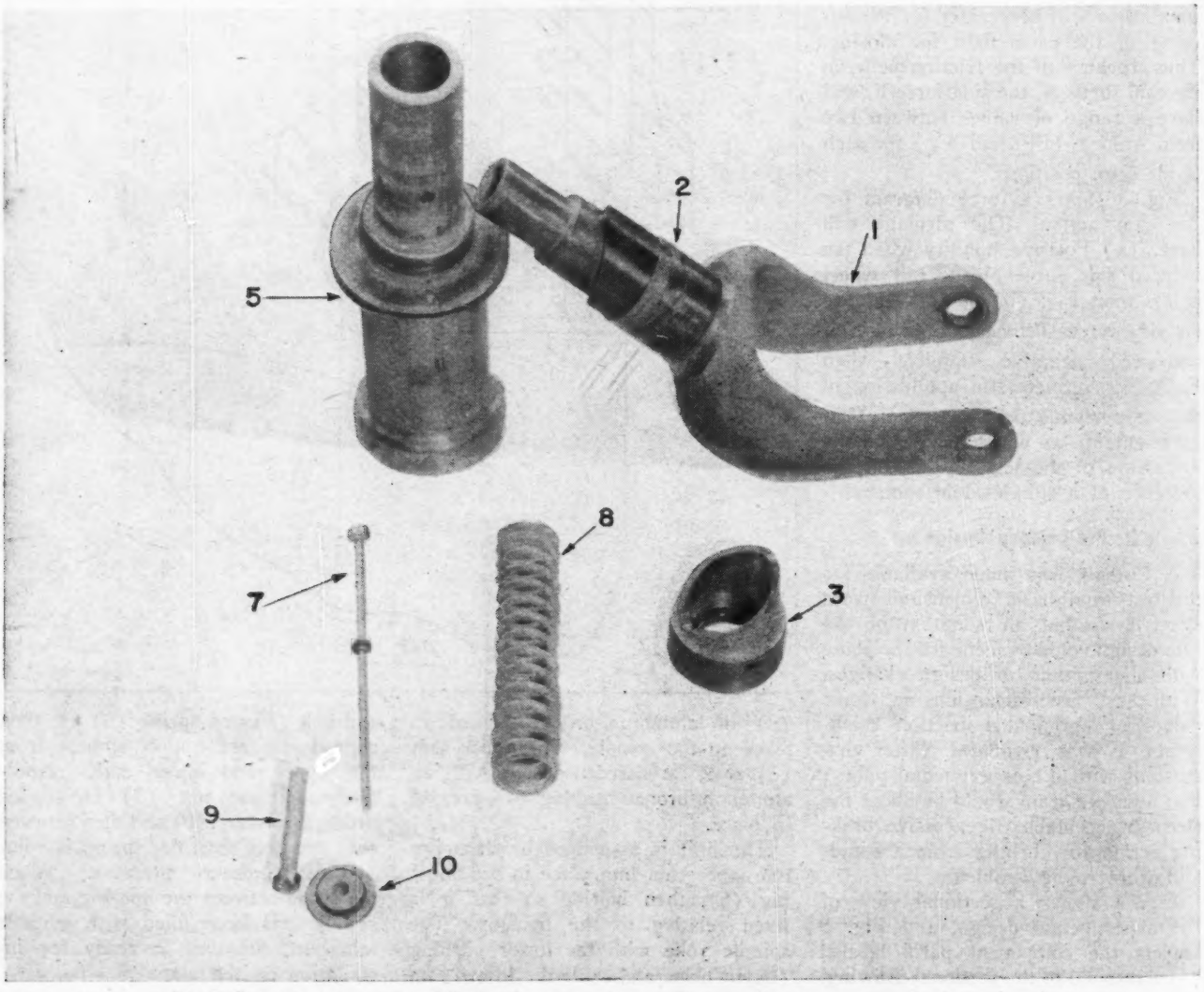


Fig. 5. Component parts of installation shown in section in Fig. 4, with units correspondingly numbered.

very satisfactory leverage action.

Thus far in the tests, one factor was evident—taxiing was simplified because the brakes were required much less for making and stopping turns, and practically not at all for straight taxiing. However, landings in crosswinds indicated that judicious use of brakes would be necessary and therefore, the 14-deg. cam would not be stiff enough for green pilots.

Hence, it was apparent that these cams would not afford best results until an adequate lubricant could be found which would permit the use of steeper units. To overcome this difficulty, a set of 14-deg. cams and a set of 16-deg. cams were made of porous material—oil-filled and self-lubricating. Some improvement was found in the centering action from the new set of 14-deg. cams but they were still too free for crosswind landings. The 16-deg. cams failed at the points in the 180-deg. position. Accordingly, the use of this porous material was abandoned.

It was then decided to revert to the aluminum-bronze and steel combination. For lubrication, a graphite dough was used—flake graphite with altitude grease as a filler—and the lubricant problem was solved. The 18-deg. cams were then installed and tested. The pilot did not find objectionable the amount of brake necessary for making turns from a standstill, and the extra brake necessary could be essentially eliminated by using down-elevator during the turn. All non-fast turns automatically straightened when the brake was released, and as with tricycle gear some brake was necessary to hold a turn. High-speed turns would automatically come out if not held too long (not more than about 15 deg.). However, crosswind landings with the 18-deg. cam indicated that it might also prove hazardous for the green pilot.

Accordingly, the 22-deg. cams were installed again, this time with graphite dough, and gave substantially same taxi characteristics observed with the 18-deg. units. The tail wheel was adequately stiff for crosswind landings and should not prove hazardous except with very awkward use of brakes.

Into-wind landings did not require brakes for directional control and the opinions of the seven pilots who tested the 22-deg. cams, was very favorable—agreeing that these cams did simplify and improve taxiing and landing. They were particularly pleased with the removal of the lock control—one less to remember. Unfortunately, it has not been definitely established that the 22-deg. cam is optimum. Thus, a 24-deg. cam may still be tolerable at low speeds and provide additional security for crosswind landing. However, it is believed that a practical start has been achieved and that further improvement should await experience in service.

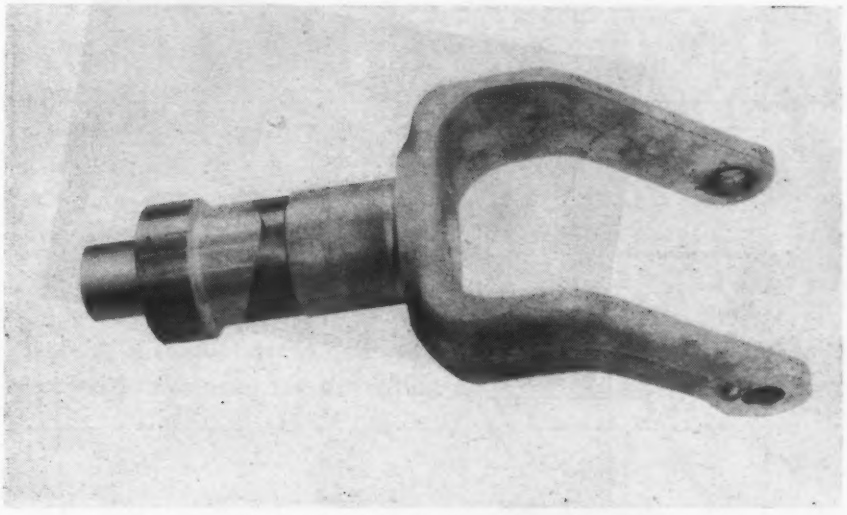


Fig. 6. Position of cams at zero deg.

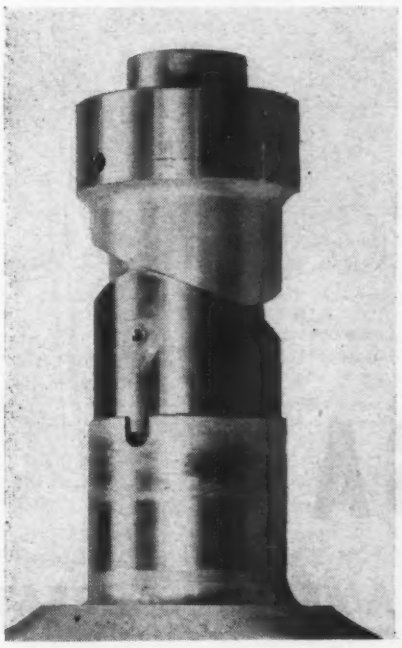


Fig. 7. Position of cams at 90 deg.

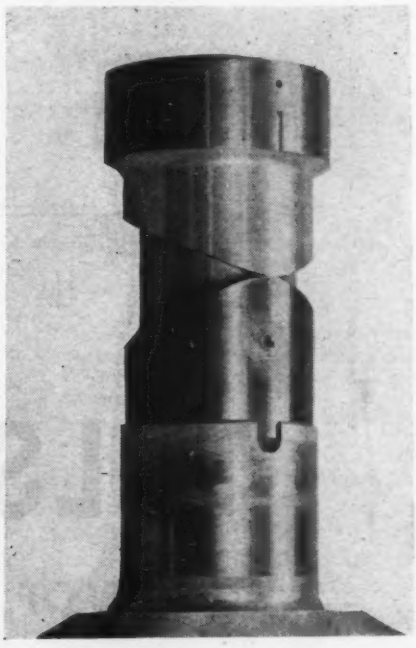


Fig. 8. Position of cams at 180 deg.

The results indicate that the centering tail wheel does have some faults. Turns on soft ground or ice will be more difficult than usual, and in a ground crew handling-test on the 18-deg. cams, although it took quite a bit of effort, four men at the tail could open the cams and swing the plane. The 22-deg. cam was not so tested and it is expected that as many as five men may be needed to swing the plane, with such installation. One man can turn the tail wheel easily with the handling bar. If any of the difficulties mentioned were considered of sufficient importance in a particular installation, they could be eliminated by use of an external release located at the tail wheel, and pilot or crew could temporarily release the cam action. However, such modification would detract from the simplicity of the unit.

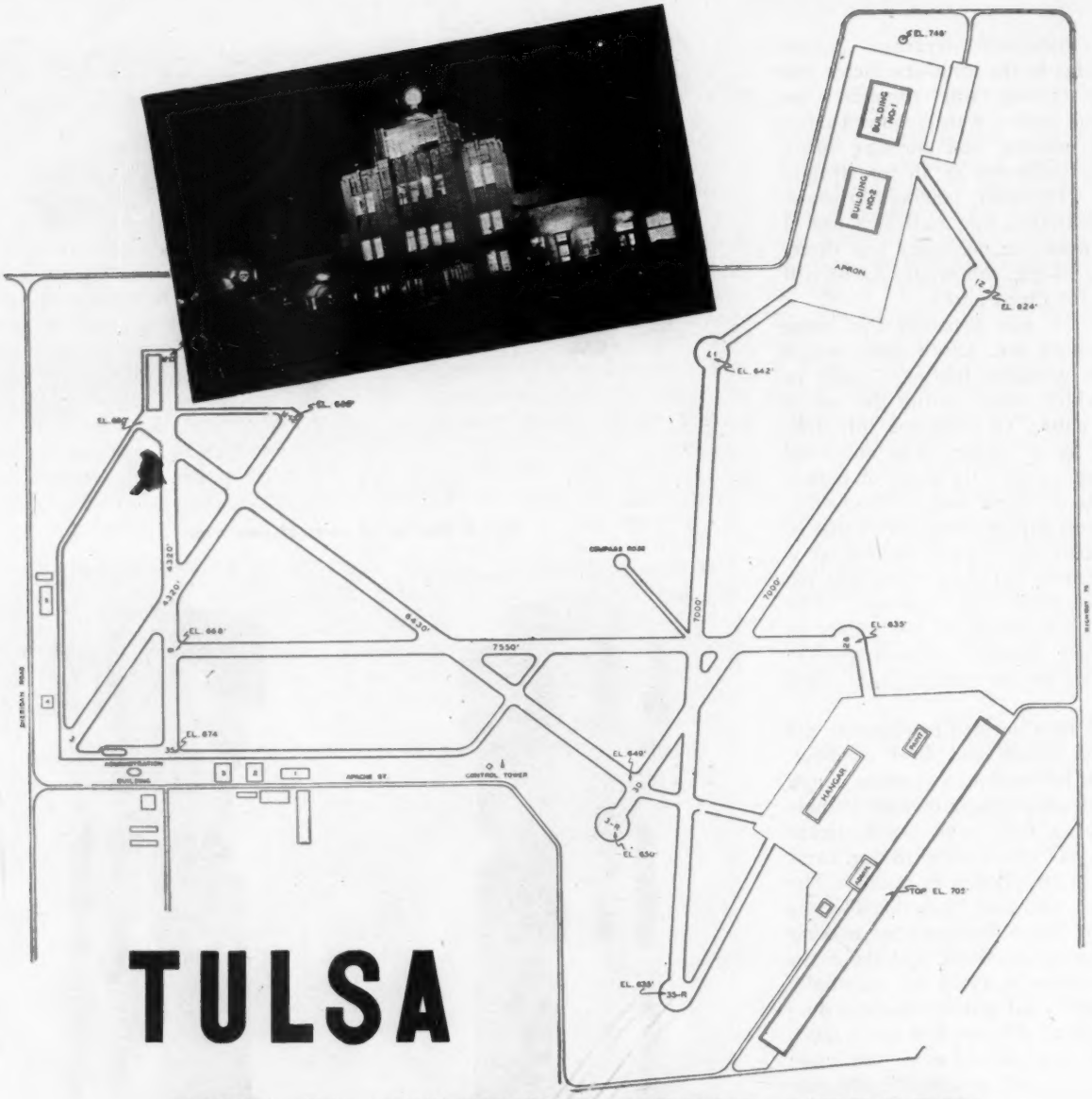
The advantages of the installation may be summarized as:

(1) The plane is directionally stable for normal taxiing conditions, hence taxiing is simplified and requires less attention from pilot.

(2) Pilot has one less control to remember for takeoff and landing—lock control is removed. The cams provide a positive lock until condition of neutral stability is reached.

(3) A positive anti-shimmy tail wheel is provided, and shallow cams may prove practical for heavily loaded nose wheel installations.

(4) Longer and better service will be procured from brakes because they will not have to be applied as frequently.



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DE-ICER PUMPS DEMAND EXPERT CARE

Herein, a special technique is described for servicing and testing Romec pumps used for operating de-icers and instruments.

THERE ARE TWO SIZES of this pump, the smaller one (Fig. 1) having a plain casing while the larger (Fig. 2) is provided with ribs for cooling. Each series is made with various drives, as shown in Table I. Otherwise there is no difference between the two so far as principle or servicing are concerned.

Operation is on the rotary principle, there being two vanes mounted in an eccentrically placed rotor in the cylindrical pump liner. In order to assure a close fit between the blades and liner, blade ends are fitted with rockers which follow closely the crescent-shaped walls of the displacement chambers (Fig. 3). Rotation may be in either direction with equal efficiency.

Lubrication, which is automatic, is regulated by an oil meter built into the pump. Parts are shown in Fig. 4 and the assembled meter in Fig. 5. Oil is taken from engine pressure lubrication system, either through a port in the mounting pad or by means of an external pipe connected to the engine.

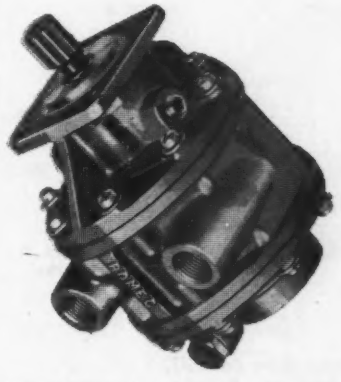


Fig. 1. Model RD-3870 Romec vacuum pump with 12-spline drive. Models RD-2112 and RD-4500 differ only in type of drive.

Fig. 2. Model RD-2200 with tongue drive. This fin-cooled pump is same as RD-3880 and RD-4990, except for difference in drive.

Inspection and Servicing

Tools used for these operations are shown in Fig. 6 and may be purchased from the pump manufacturer or made from 1020 steel and cyanide, hardened.

Preflight. Check vacuum gage for inlet pressure. Gyro-horizon and directional gyro use 4 in. Hg vacuum, while turn-and-bank uses 2 in., with vacuum regulator (Fig. 7) to give reduced pressure. For troubles and remedies see Table I.

Every 25 hr. Check installation for leaks or loose fittings. Clean suction regulator screen. Check castings for excessive oil film, which would indicate leakage through cracks.

Every 200 hr. Remove oil meter cap nut and clean out sludge; while apart, lift flat spring in cap to increase pressure against metering plate. If driving pin and metering plate have been separated, punch mark at one of the numbers indicates correct notch for reassembly. Remove hex plug in lefthand end plate over oil meter. If operating properly, oil should bubble from opening, when running pump.

Lubrication is automatic, therefore oil does not require replenishing. Adjustment of oiling rate is considered later under test instructions.

Disassembly

Referring to Fig. 8, remove pump from engine. Then perform following operations: (a) Remove all fittings, plugs, and lockwires; (b) use wrench T-20 to remove seal nut, turning counterclockwise; (c) lift out coupling assembly; (d) using wrench T-17, take off cap nut from end opposite to drive, turning counterclockwise; (e) lift out oil metering plate and driver, taking great care not to scratch lapped surfaces; (f) remove eight screws and washers from drive end plate, then remove plate, being careful not to lose needle bearings, also do not try to remove thrust plates, which are doweled into end plates; (g) remove opposite end plate and mark for identification; (h) lift out rotor, blades, and rockers, together with filler plate, shims, and ball bearing; (i) using puller T-32, remove ball bearing from rotor, after which lift off filler plate and shims (*do not attempt to remove ball bearing except by using tool T-32;* (j) remove four gaskets and oil line sleeves (if any) from body or end plates; and (k) wash all parts carefully in gasoline or cleaning fluid and remove any slight burrs which result during disassembly.

Inspection and Repair

Check all internal parts to see that no sharp corners have been rounded, since this would cause leakage in pump when working.

Scored or worn blades or rockers should be replaced. Check blades for end wear and slot clearance. End clearance less than .008 in. and slot clearance less than .0025 in. will be satisfactory.

Inspect ball race for wear and shaft fit. There should be light-press fit on shaft and finger-push fit in end plate.

Replace filler plate lock pins *if worn.*

In case of seizing of pump through lack of oil, blades and rockers must be replaced and any galled aluminum removed from end plates, liner, and rotor slots. Check rotor for any other damage.

Inspect faces of thrust plates and mating faces on pump body. They should be smooth and abrasion-free.

Clean oil channels in end plates with compressed air and blow out all oil passages on other parts.

Examine driving members and sealing surfaces and replace any badly worn parts. Slightly worn sealing surfaces can be lapped, but should never be ground. Steel seal plate can be lapped on a flat iron plate with fine carborundum, taking care that mixture is not too wet, as this will

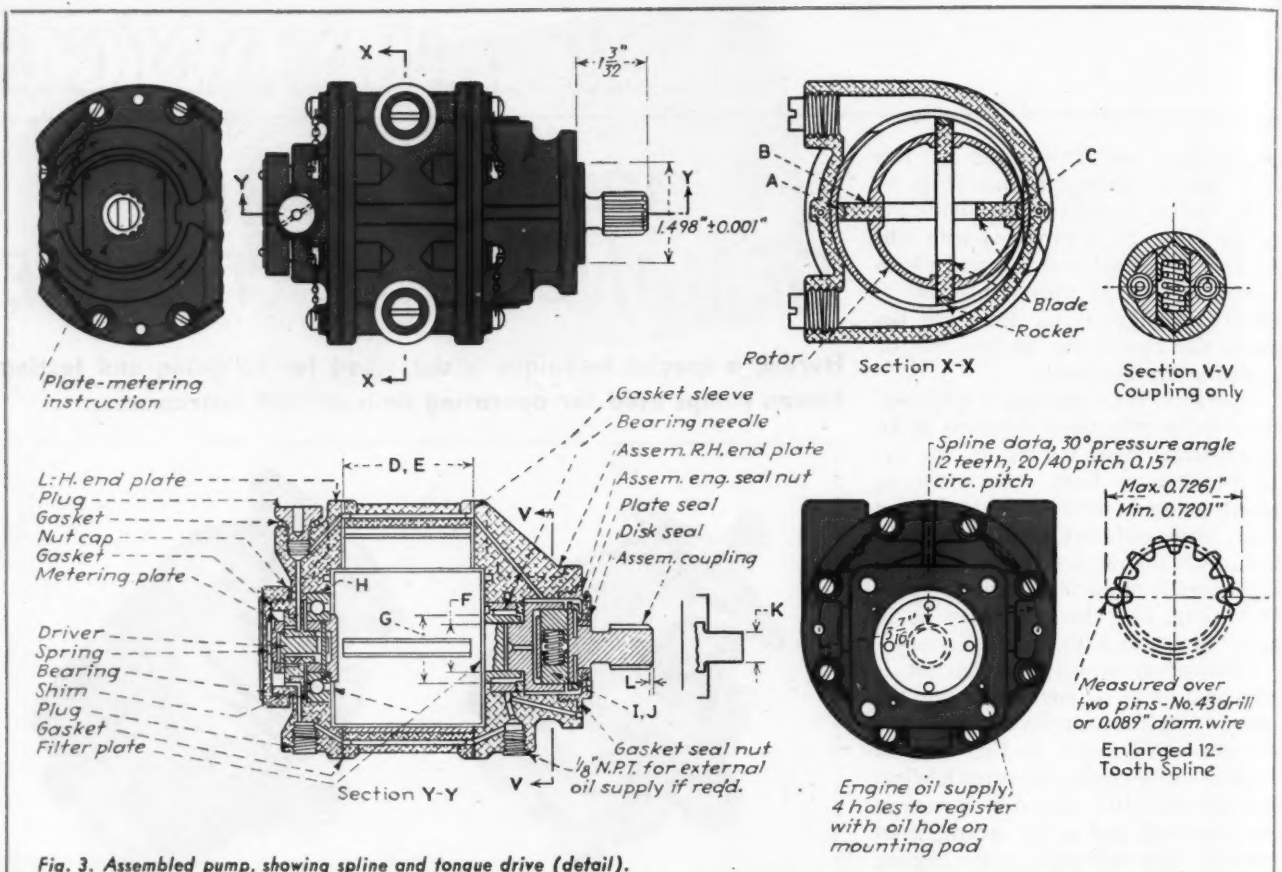


Fig. 3. Assembled pump, showing spline and tongue drive (detail). At right is seen method of measuring splines for wear. Pumping action is caused by motion of blades, which slide in rotor while maintaining contact with walls of liner, specially curved to permit blade ends to follow them. References A to L apply to Table II.

cause irregularity. Bronze seal seat in seal nut is refinished by holding against rapidly rotating, fine round hone, lubricated with gasoline. If seat does not clean up within 1 min., take a light cut on a bench lathe and repeat honing. *Lapping compound must never be used with bronze surfaces.*

Replace seal disk and cap-nut gasket on oil meter with new ones. If pin in metering plate is excessively worn, replace entire metering plate assembly.

If wear in oil metering plate driver notches causes loose fit in plate, install new driver. Inspect lapped surfaces and see that they are in good condition. Minute oil holes must be clear.

Reassembly

Lubricate all parts with AN-VV-O-446 oil, Grade 1120 (SAE 60).

To install end plates on body, first inspect to insure replacement at same ends as formerly. Insert oil line sleeves in upper and lower channels in end of body away from drive end. Then place sleeve gaskets in mating channels in end plates. Cover mounting surfaces of end plate and body with thin covering of synthetic rubber cement—Spec. (2)26571)— to within ¼ in. from edge. Fit end plate over dowels in body, carefully aligning oil sleeves and gaskets. Fasten with eight screws and washers.

Check alignment of rotor in liner to see whether dowel pins give correct clearance at seal line (see Reference C of Fig. 3). With ball bearing in place on shaft, insert rotor in body after using Prussian blue for spotting on surface. Turn rotor with tool T-33. Minimum clearance—.00025 in.—should just allow rotor to wipe liner at point of contact. Since there is no wear at seal line, end plate assembly should be reset and doweled when clearance is over .0015 in.

Assemble blades in rotor in same position and in reverse order in which they were disassembled.

To provide necessary end clearance, stand rotor on drive end. Place filler plate, then shims, over shaft end away from drive. Follow with ball bearing. Coat filler plate with heavy oil, so that it will stick to rotor, then turn plate until one of three pins is in line with blade end. By sighting along this blade, when inserting this assembly into body, line up pins into holes in end plate. Tap assembly into place with fiber hammer until it bottoms. Blade ends should wipe very lightly on thrust plate. Make sure that blades wipe thrust plate correctly by shimming behind ball bearing. When removing ball bearing use tool T-32.

Insert rockers on blades, selecting sizes with not over .015 end clearance

Fig. 4. Integral oil meter parts. L. to r.: End plate showing metering plate seat; metering driver; metering plate; spring; gasket; and metering cap nut.

Table I—Tolerances and Clearances (*Refer to Fig. 3*)

Ref.	Part	Description	Models RD-2112, RD-3870 and RD-4500				Models RD-2200, RD-3880 and RD-4990				Remarks
			Dimen. new max. and min.	Permissible worn dimen. max. or min.	Clearance new max. and min.	Permissible worn clearance max.	Dimen. new max. and min.	Permissible worn dimen. max. or min.	Clearance new max. and min.	Permissible worn clearance max.	
A	Rocker	Clearance between rocker and liner.			0.015 0.006	0.020			0.015 0.006	0.020	Blades with badly worn rocker grooves should be replaced when tolerance equals 0.020.
B	Blade	Clearance between blade and rotor slot.			0.002 0.0005	0.002			0.0025 0.001	0.0025	Blades may be selected to give correct clearance.
C	Liner-Rotor	Clearance between rotor and liner at bottom.			0.0015 0.00025				0.0015 0.00025		Excessive clearance affects pump performance. A bright line at point of contact between liner and rotor denotes a good fitting rotor. This clearance is governed by the position of the dowels for locating the end plate assemblies (35) and (36) on to the body (32). Damaged dowels or distorted body may change original factory setting.
D	Liner-Blade	Difference in liner length over blade length.	0.003 0.0015			0.004	0.008 0.005			0.008	Lengthwise position of blades to liner and clearance at thrust plates is established by shims behind ball bearing. See sec VI, par. 4, No. 3.
E	Liner-Rocker	Difference in liner length over rocker length.	0.003 0.0015	0.004			0.0075 0.0045	0.0075			
F	Inner Race	Outer dia. of needle bearing inner race.	0.937 0.936				0.937 0.936				Fitted on drive end of rotor
G	Outer Race	Inner dia. of needle bearing outer race.	1.0645 1.0635				1.0645 1.0635				Fitted in R.H. end plate assembly.
H	Ball Bearing										Ball bearing should be free from excessive end float, roughness and wear. The bearing is a light drive fit on the rotor shaft, and a light push fit in bearing housing.
I	Coupling Plunger	Diameter.	0.4365 0.4355				0.4365 0.4355				Plungers should be replaced if grooved or scarred on angular surfaces. Wear on diameters of plungers and diameter of bore (ref. J) in coupling is generally negligible.
J	Engine Seal Coupling	Dia. of bore for plungers.	0.4385 0.4375				0.4385 0.4375				
K	Engine Seal Coupling RD-2200 Pumps	Clearance between tongue and engine drive slot.	0.1985 0.1980		0.0025 0.0010		0.1985 0.1980		0.0025 0.0010		Measured at widths of tongue and slot.
L	Engine Seal Coupling	End play.	0.010 0.005			0.010	0.010 0.005			0.010	Measured with engine seal nut (22) installed.

and small radial clearance (max permissible is .0015), because too much clearance at this point will affect pump performance.

Turn rotor slowly to check for tight or sticky spots.

Coat needle bearing inner race with heavy oil and assemble the 50 needle bearings around shaft, using small magnetized tool for handling them.

To reassemble drive end plate on pump, place a sleeve in each oil channel and fit a gasket over them. Clean thrust plate, then dowel onto end plate. Lightly cover with synthetic rubber cement, as with other end plate, and place filler plate in position in body, with dowel pins in holes, then slide end plate over needle bearings, dowel pins, and oil sleeves, and finally fasten with screws and washers.

Blow out oil channels with air pressure. Turn rotor with tool T-33, which fits coupling slot closely. There should

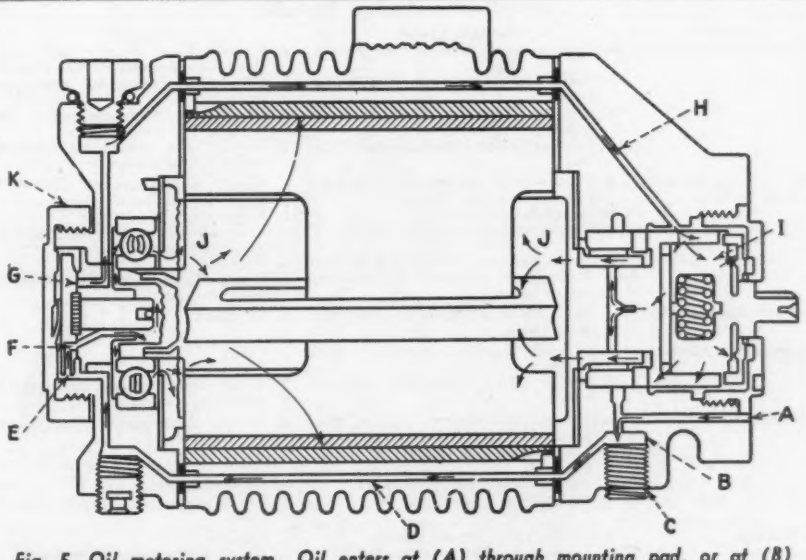


Fig. 5. Oil metering system. Oil enters at (A) through mounting pad, or at (B) through external pipe, which is plugged by (C) when not in use. (D) is passage leading to meter plate (E) which makes controlled delivery through openings (F) and (G). Adjustment is by selective misalignment of (E) with (F) and (G) by means of nut (K). Metered oil flows through passage (H) to internal working surfaces (J)

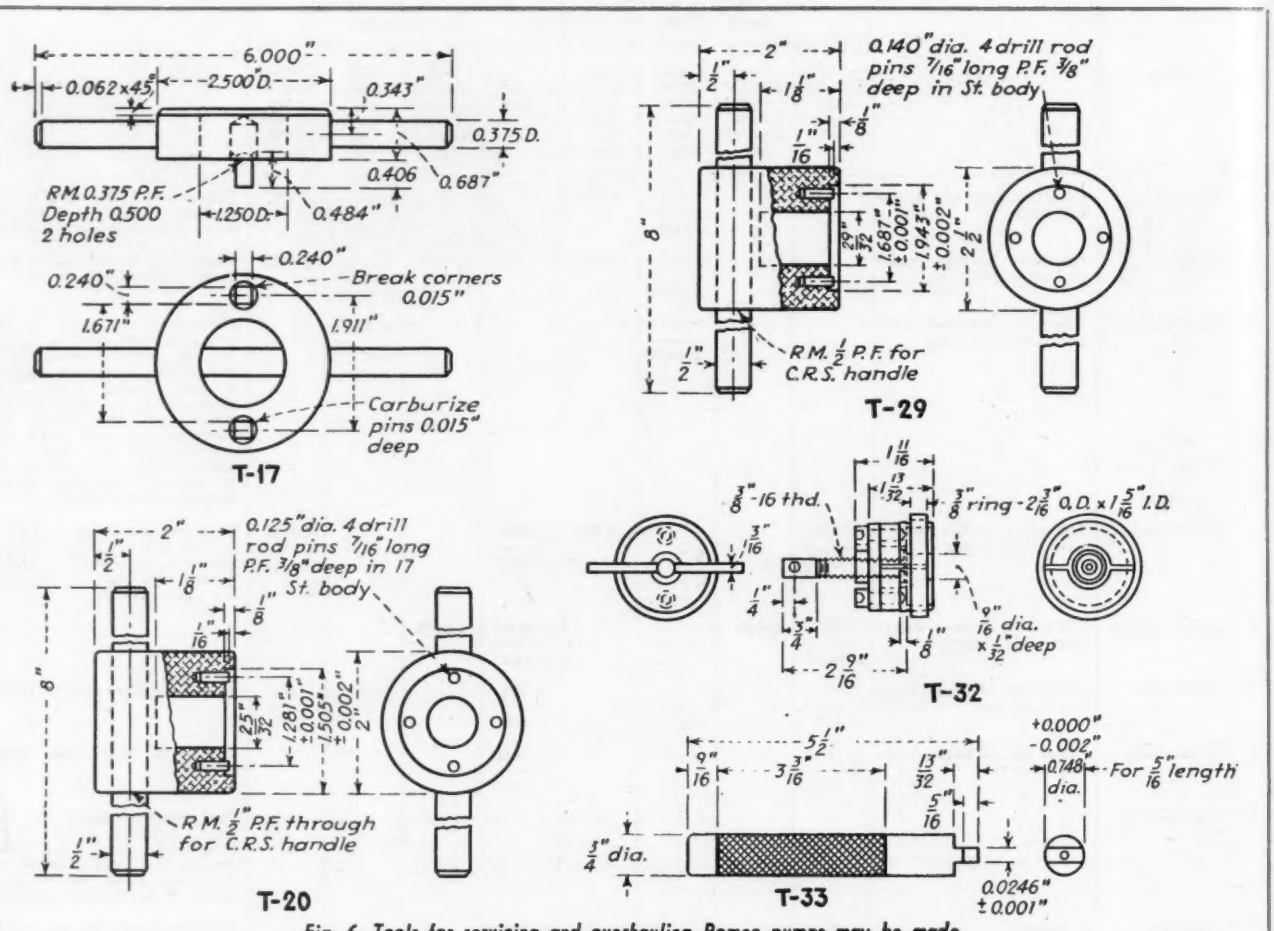


Fig. 6. Tools for servicing and overhauling Romec pumps may be made from 17ST and cold rolled 1020 steel, carburized where indicated.

be no pronounced tight spots evident.

To insert coupling, first place sealing springs, driving spring, and two coupling plungers in engine seal coupling. Using large adjustable pliers, compress coupling plungers inward and slide into pump seal coupling. Install seal disk in seal plate and slide over spline coupling and seal assembly so that it engages with rotor, using a new seal nut gasket.

Screw engine seal nut over coupling, making sure that drive lugs on seal plate are in slots in driving member. Use either T-20 or T-29 wrench, according to model.

To reassemble oil meter, stand pump on drive end. Place metering driver in metering plate assembly. Metering cap nut is punch marked, showing factory setting.

Lightly coat driver and end plate with oil and insert in metering plate seal, turning them so that slotted driver end fits over rotor drive pin.

Place metering plate spring in metering cap nut and stake in four places to hold spring in place. Using new metering cap gasket, screw the nut down tightly with wrench T-17.

Table II—Troubles and Remedies

Trouble	Probable Cause	Remedy
Broken splined coupling.	a. Seizure from lack of lubrication.	a. Check oiling system and repair; check for damaged parts and replace.
	b. Seizure of pump from foreign material.	b. Check for damaged parts and replace.
	c. Seizure of pump from jamming blades.	c. Check for damaged parts and replace.
	d. Crystallization from torsional vibration.	d. Replace the engine seal coupling and coupling plungers.
Low pumping capacity. (Inlet or outlet).	a. Worn blades, rotor slots and rockers, causing improper clearances.	a. Check parts against Table II. Replace worn parts.
	b. Insufficient lubrication.	b. See below.
	c. Faulty suction regulator valve.	c. Clean and free moving parts for proper operation.
	d. Broken or leaky air lines or fittings.	d. Replace.
	e. Improperly adjusted air pressure safety valve.	e. Readjust to meet de-icer system specifications.
Low vacuum reading.	a. Improperly adjusted suction regulator valve.	a. Readjust.
High vacuum reading.	a. Plugged suction regulator valve screen.	a. Clean.
	b. Sticky valve in suction regulator valve.	b. Clean and free moving parts for proper operation.
Insufficient lubrication.	a. Clogged oil lines, end plates, body and/or oil meter within the pump.	a. Clean. Disassemble if necessary.
	b. Metering assembly out of adjustment.	b. Reset meter.
	c. Wrong engine gasket installed.	c. Replace gasket.
	d. Interrupted oil supply.	d. Check engine oil pressure and oil lines.
Oil leakage.	a. Faulty metering cap gasket.	a. Replace.
	b. Loose metering cap.	b. Check gasket and tighten cap.
	c. Leaky flange joints.	c. Disassemble, clean thoroughly and seal joints with synthetic rubber cement.
Excessive oil in de-icer system.	a. Clogged oil drain from oil separator.	a. Remove drain connection and perforated disk. Clean and reassemble.
	b. Sludge in oil separator.	b. Remove and flush out.
	c. Excessive oil metering rate.	c. Readjust.

Test Stand and Testing

Test stand (Fig. 9) contains following equipment: (1) Reversible speed unit, with control accurate within 25 rpm.; (2) suction manometer on inlet line near pump, with suction control valve and means for measuring air flow; (3) manometer and pressure control valve on outlet line, with thermocouple for temperature readings and expansion tank for exhausted air and oil; and (4) lubricating and oil-flow measuring equipment, con-

Table III—Pump Capacity

Type	Model	Type of Drive	Mounting Hole Centers	Capacity Cu. Ft. per Min. 1500 R.P.M. 4" Hg Suction 1" Hg Discharge	Capacity Cu. Ft. per Min. 2250 R.P.M. 4" Hg Suction 16" Hg Discharge	Port Size	Net Wt. Lbs.
B-3	RD-2200	Tongue	1⅜" x 1⅜"	7½	8	½"	5
B-3B & B-7	RD-3880	12-Spline	1⅜" x 1⅜"	7½	8	½"	5¼
B-3G	RD-4990	12-Spline	4 Holes 5" Dia. B.C.	7½	8	½"	5½

Type	Model	Type of Drive	Mounting Hole Centers	Capacity Cu. Ft. Min.	Port Size	Net Wt. Lbs.
B-2A	RD-2112	Tongue	1⅜" x 1⅜"	4½	⅜"	4
B-2B & B-6	RD-3870	12-Spline	1⅜" x 1⅜"	4½	⅜"	4 1/10
JB-2A	RD-4500	6-Spline	4 Holes 5" Dia. B.C.	4½	⅜"	4¼

* Capacity: Cu.ft./min. at 1,500 rpm., 4" Hg suction and 1" Hg discharge.

sisting of reservoir and air pressure regulator set to 50 psi., the whole being connected to pump at regular lubrication point. All the above are shown in Fig. 9.

Break-in run. Lubricate with AN-VV-O-446, Grade 1120, (SAE 60) and turn a few times by hand, both to assure free motion and to distribute the oil. Mount on test stand and run in same direction as when on engine. During first hour, speed is 2,500 rpm., in second hour, 3,750. During break-in run, inlet and discharge pipes and valves are wide open.

Capacity test. Take capacity readings at 1,500 rpm. at 4 in. Hg suction and 1 in. Hg discharge pressure. Capacity should be as shown in Table III. Then raise rpm. to 2,250 and discharge to 16 in. Hg with same suction, checking discharge capacity from Table III.

Oil leakage along shafts should not exceed two drops per min. There should be no leakage whatsoever at any other points.

Oil consumption. Operate at 3,750 rpm., 5 in. Hg suction and 16 in. Hg discharge pressure until temperature is stablized. Maximum rise should not be more than 120 deg. C. (248 deg. F.) above room temperature.

Operate at 3,750 rpm., 5 in. Hg suction and 16 in. Hg discharge, with oil line pressure about same as in engine to which pump will be attached. If this is not known, 50 psi. is standard oil pressure and should be used. Measure oil input on graduated gage glass on tank. If feed is not over 55 cc. per hr. nor less than 33 cc. for RD-2112-3870-4500, and not more than 55 cc. nor over 75 cc. for RD-2200, -3880, and -4990, adjustment is correct. Oil meter is adjustable within limits marked on Table IV.

Installation

If pump has been in storage, remove shipping plugs and lubricate with SAE 60 engine oil. Turn by hand to assure freedom of parts.

Check direction of rotation of engine drive. Arrow on pump which points in direction of engine rotation also points to inlet port.

Place gasket over studs on engine pad, making sure that oil hole in pad lines up with those in gasket and in pump (unless separate lubrication is used, in which case there will be no oil hole in gasket). Make sure pump pilot does not bind when entering.

Suction regulator valve should be as close to inlet port as possible (Fig. 10), and all tubing both here and elsewhere in the installation should be securely clipped to prevent breakage from vibration.

Oil separator. Oil meter, integral with pump, may be set to give exact oil requirements, so that exhaust may be piped directly overboard. However, an oil separator (Fig. 11) should be used with de-icers, because elimination of oil is essential before air is used for boot inflation. Separator should be higher than oil reservoir to permit

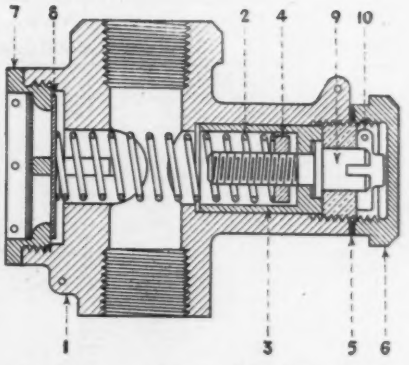


Fig. 7. Vacuum relief valve which regulates vacuum obtainable by pump. Body is at (1), (2) is valve spring, (3) adjustment screw guide screw sleeve, (4) spring adjustment nut, (5) valve cap gasket, (6) valve cap, (7) valve seat assembly, (8) disk valve, (9) valve adjustment screw, and (10) screw lock.

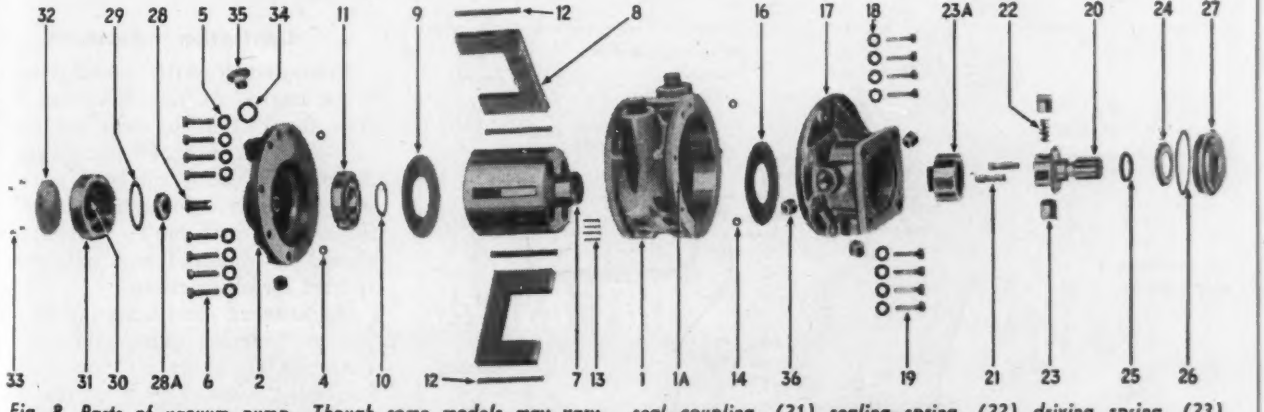


Fig. 8. Parts of vacuum pump. Though some models may vary slightly, parts will be recognizable from this illustration. At (1) is body assembly with liner, (1a) is dowel pin for locating end plates, (2) left hand end plate with metering plate seat, (3) oil line sleeve, (4) sleeve gasket, (5) washer, (6) end plate screws, (7) rotor, (8) blade, (9) filler plate, (10) shim—made in five thicknesses, (11) ball bearing, (12) blade rockers, (13) needle bearings, (14) oil-line sleeve, (15) gasket, (16) filler plate, (17) drive end plate, (18) washer, (19) end plate screws, (20) engine seal coupling, (21) sealing spring, (22) driving spring, (23) coupling plunger, (23a) pump seal coupling, (24) seal plate, (25) flexible seal disk, (26) seal nut gasket, (27) engine seal nut assembly, (28) metering driver, (28a) metering pin locating plate assembly, (29) metering cap gasket, (30) metering plate spring, (31) metering cap nut, (32) metering instructions plate, (33) drive screws for instruction plate, (34) copper asbestos gasket, and (35) and (36) plugs. In larger models, outside of body (1) is provided with ribs to dissipate heat.

Table IV—Pump Oil Consumption

(Approximate Oil Quantities for Preliminary Test)

Oil Delivery to Pump				Oil Recovery from Pump				
Lb. per hr.	Cc. per hr.	Lb. per ½ hr.	Cc. per ½ hr.	Lb. per hr.	Cc. per hr.	Lb. per ½ hr.	Cc. per ½ hr.	
0.04	20	0.02	10	0.032	16	0.016	8	
0.05	25	0.025	12.5	0.04	20	0.02	10	Models
0.06	30	0.03	15	0.048	24	0.024	12	RD-2112
*0.07	35	0.035	17.5	*0.056	28	0.028	14	RD-3870
*0.08	40	0.04	20	*0.064	32	0.032	16	RD-4500
*0.09	45	0.045	22.5	*0.072	36	0.036	18	
*0.10	50	0.05	25	*0.080	40	0.040	20	
*0.11	55	0.055	27.5	*0.088	44	0.044	22	
0.08	40	0.04	20	0.064	32	0.032	16	
0.09	45	0.045	22.5	0.072	36	0.036	18	
0.10	50	0.05	25	0.08	40	0.040	20	
*0.11	55	0.055	27.5	*0.088	44	0.044	22	Models
*0.12	60	0.06	30	*0.096	48	0.048	24	RD-2200
*0.13	65	0.065	32.5	*0.104	52	0.052	26	RD-3880
*0.14	70	0.07	35	*0.112	56	0.056	28	RD-4990
*0.15	75	0.075	37.5	*0.120	60	0.060	30	
0.16	80	0.08	40	0.128	64	0.064	32	
0.17	85	0.085	42.5	0.136	68	0.068	34	
0.18	90	0.09	45	0.144	72	0.072	36	

* Factory oil meter setting at 50 psi. oil pressure.

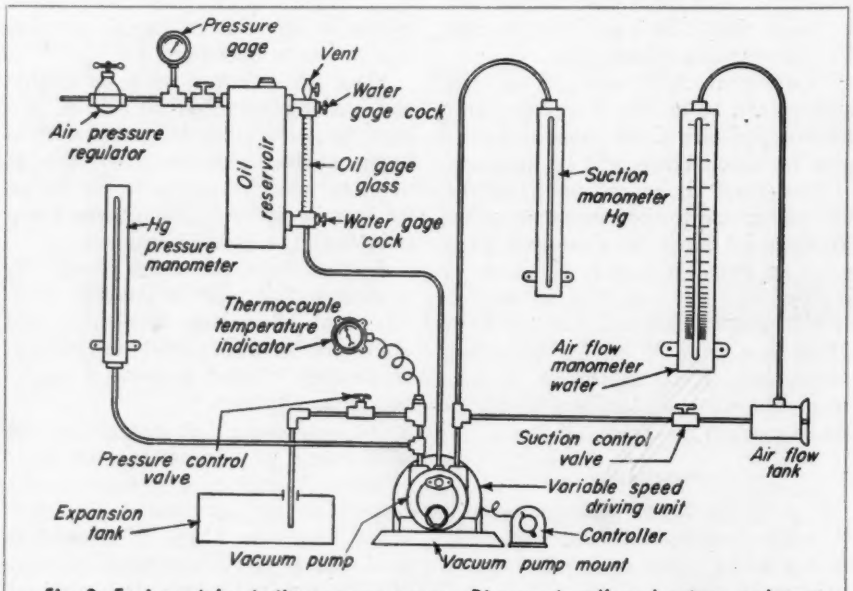


Fig. 9. Equipment for testing vacuum pumps. Diagram is self explanatory, and most instruments may be made in any well-equipped shop. In assembling vacuum testing stand, it is to be remembered that leakage is inward and for this reason is inaudible and difficult to locate unless equipment is pressure tested before using.

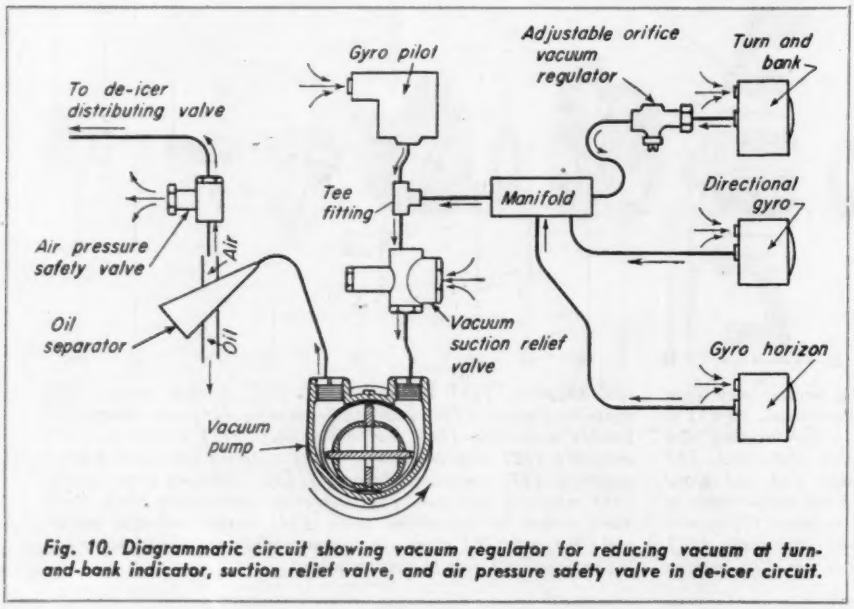


Fig. 10. Diagrammatic circuit showing vacuum regulator for reducing vacuum at turn-and-bank indicator, suction relief valve, and air pressure safety valve in de-icer circuit.

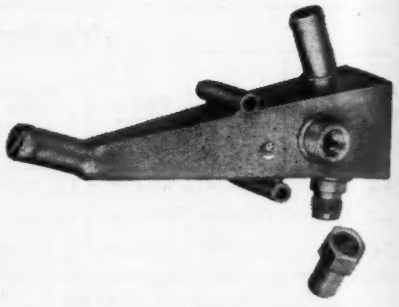


Fig. 11. One model of oil separator used to remove all traces of oil from air used in de-icer.

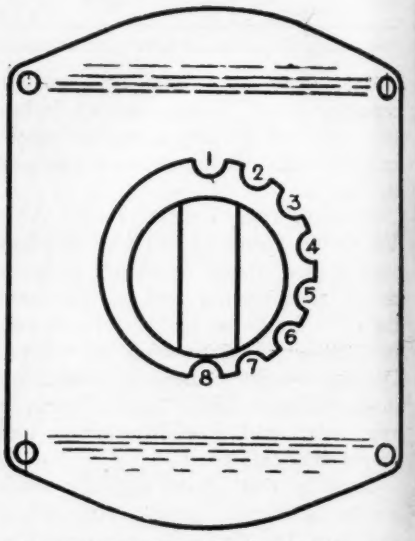


Fig. 12. Instruction plate, on metering plate cap, is used for oil adjustment. Turning to higher number increases flow. Factory adjustment is punch marked.

gravity return of oil to the engine.

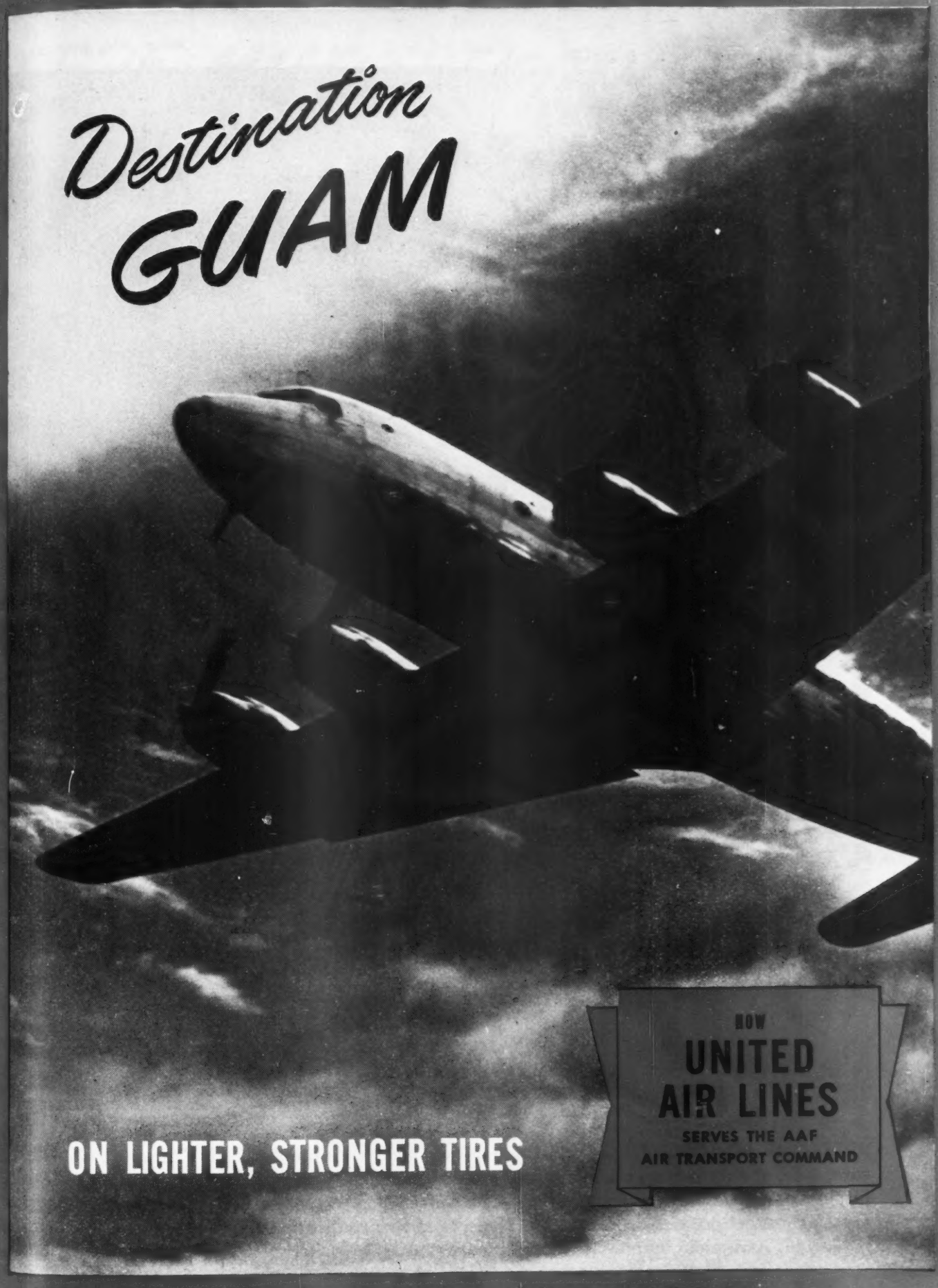
External oil line is only used when oiling is not through engine pad. Connection is made to any one of three external pipe taps on end plate. Tubing is ¼ in. o.d.

Lubrication Adjustment

Preliminary. After installation, operate engine at not less than 1,500 rpm. for 15 min. to clear out residue oil. Then run at 2,500 pump rpm. for 30 min., collecting oil from separator into container. Oil should be within limits given in Table IV; if less, pump should be removed and passages inspected for obstructions.

Adjustment. Instruction plate (Fig. 12) on metering plate, gives instructions for adjusting oil flow. Higher numbered notches give increased oil flow, and factory setting is given by punched number.

Suction regulator adjustment. With engine at 1,500 rpm., adjust suction regulator valve in accordance with airplane specifications. All vacuum-driven instruments should be adjusted after suction relief valve is set.



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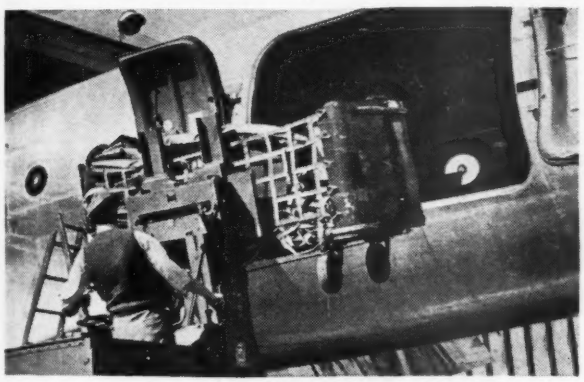

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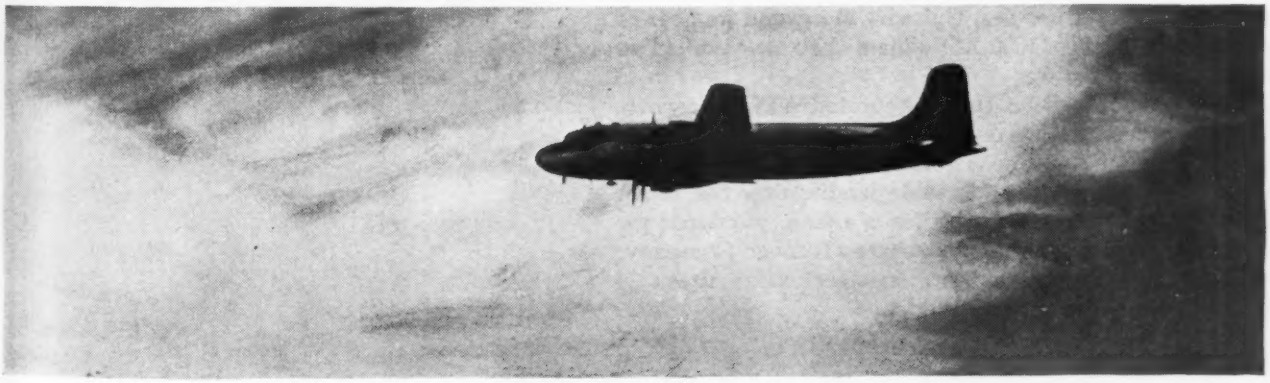

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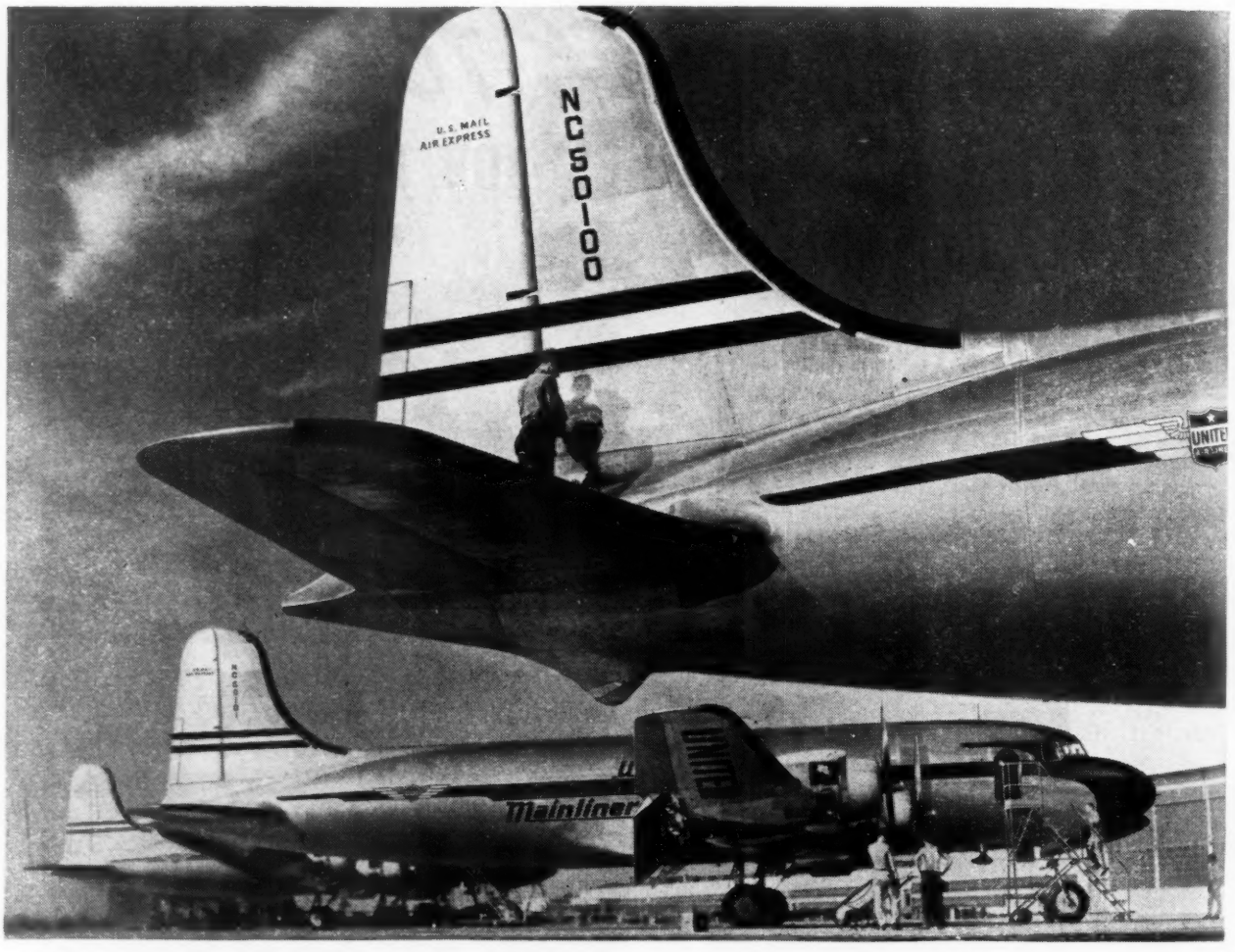

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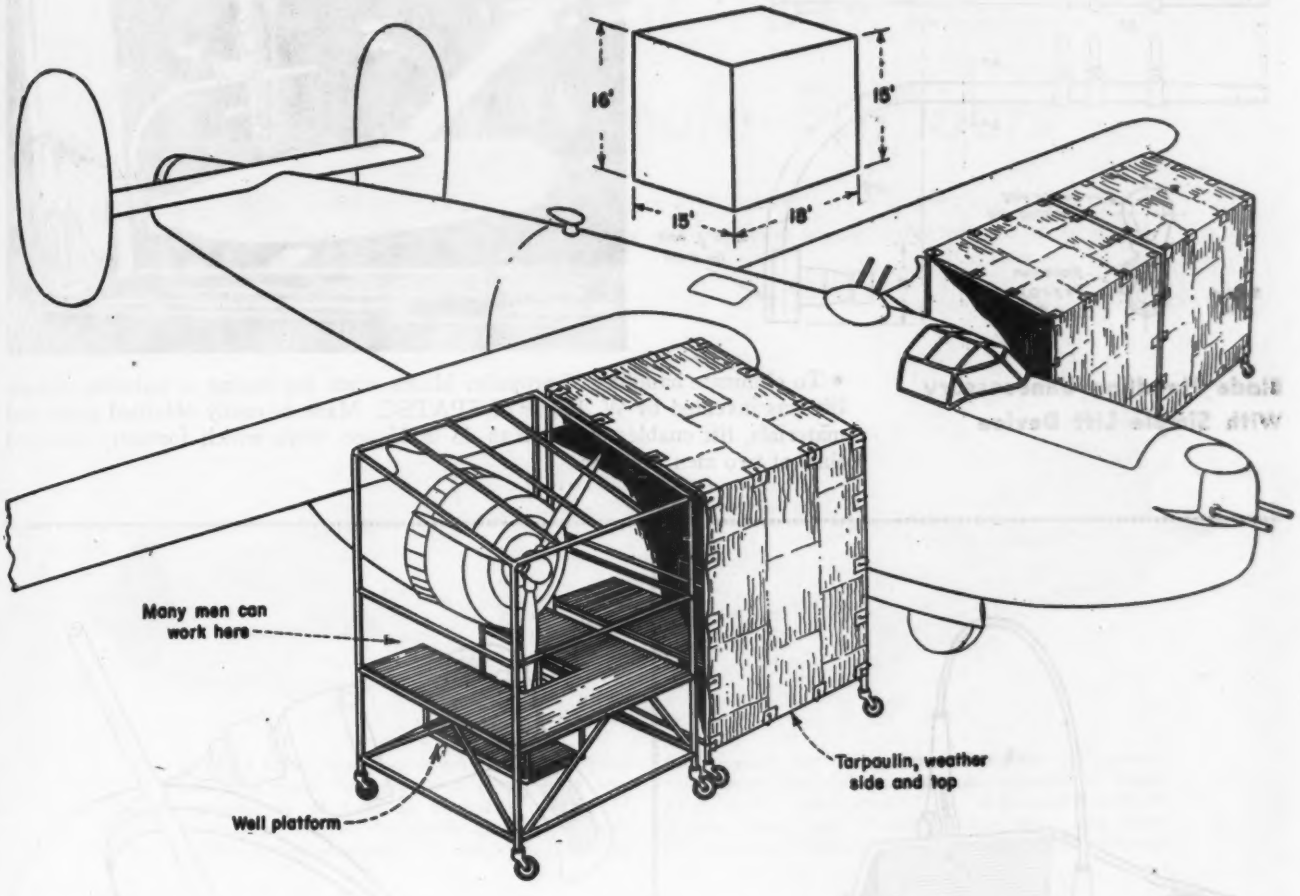
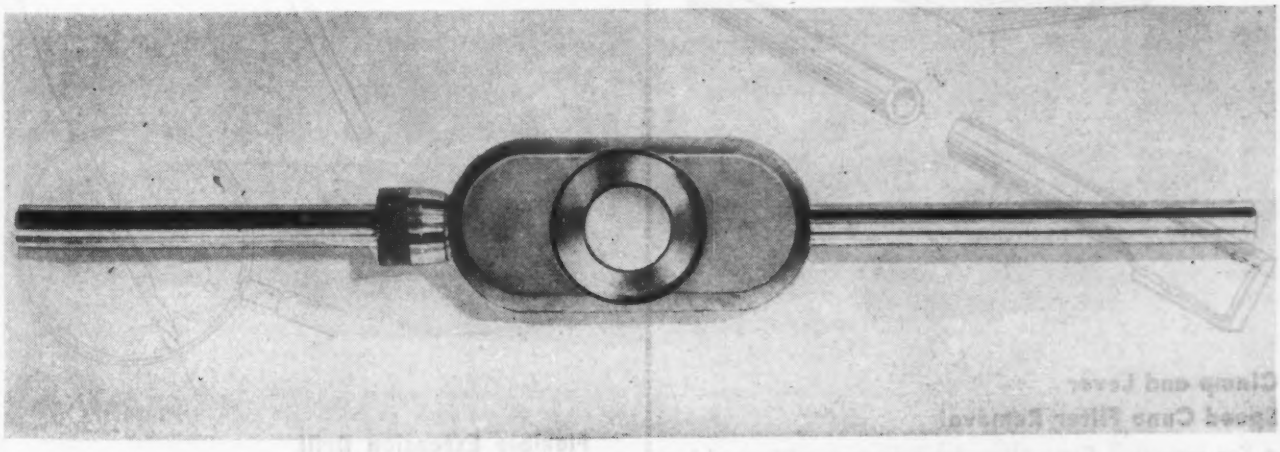


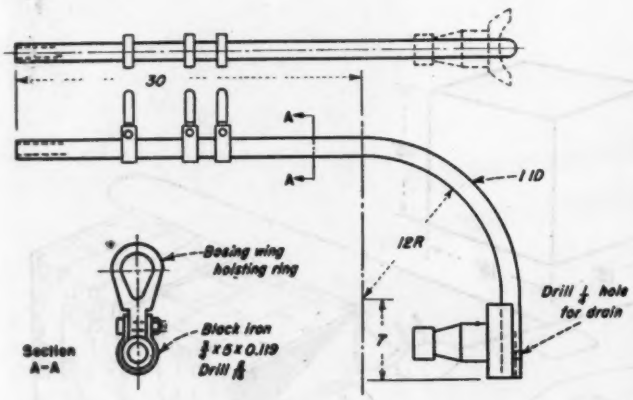
Easily Moved Shelter Expedites Line Repairs

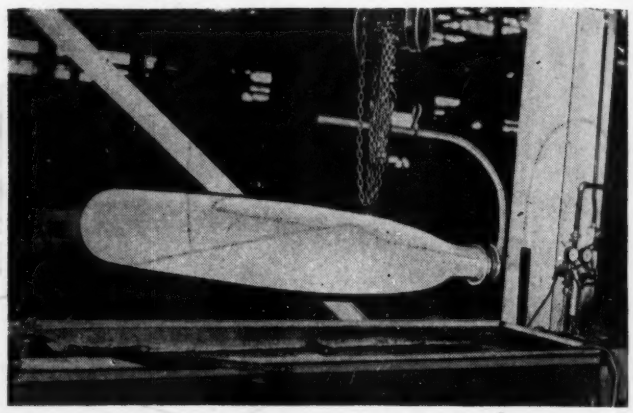
• Protection from sun, wind and rain is afforded by these portable work platforms. Built of weatherproof materials, structures have been of great use in line servicing large aircraft.



Special Mike Centers Brake Drums

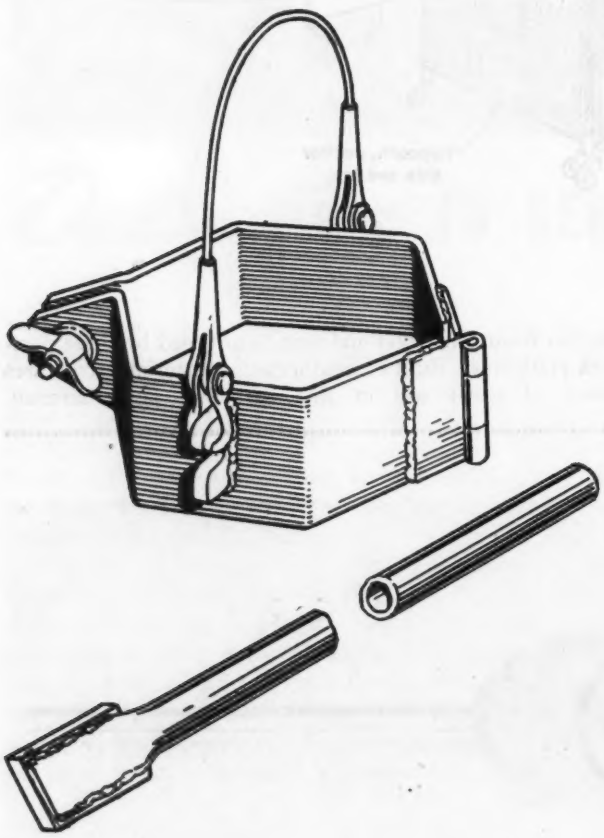
• To check ID of brake drums, machinists Schoeck and Cook of AAF at Pocatello devised this micrometer. Mounted on grinder center, expanded micrometer both checks dia. and centers drum for grinding.





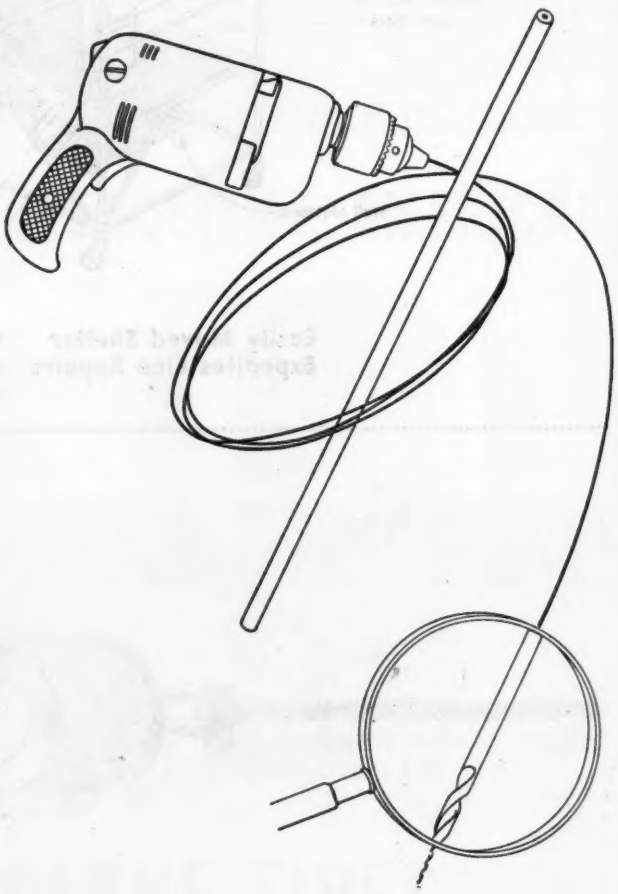
Blade Handling Unnecessary With Simple Lift Device

• To eliminate handling of propeller blades when degreasing or painting, simple lift was invented by W. Edgar of SPATSC. Made of easily obtained parts and materials, lift enables one man to do in 15 sec. work which formerly required time of two men for ½ hr.



Clamp and Lever Speed Cuno Filter Removal

• For removing Cuno filters from engines without risk of damage, Walker L. Elrod of Delta made this special clamp. Attached by tightening wing nut, this invention enables filter to be withdrawn by means of lever applied under cable bail. Use of this tool has greatly facilitated servicing of filter units.

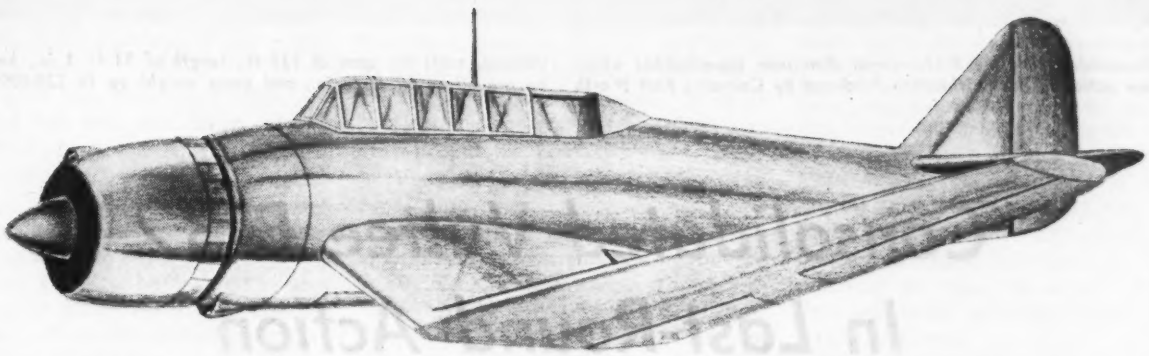


Flexible Extension Drill For Reaming Long Hinges

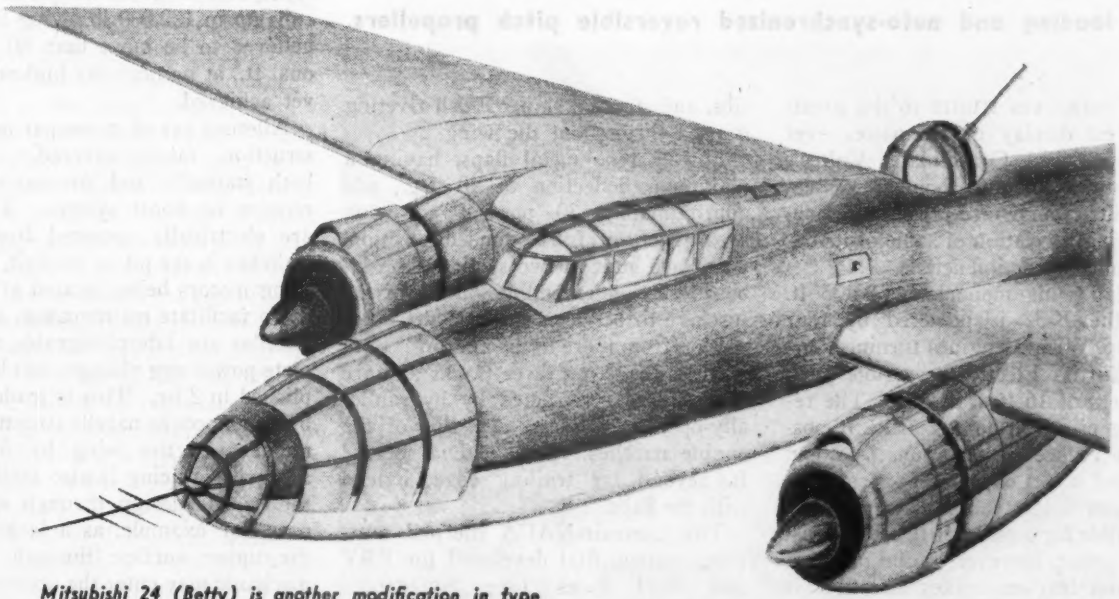
• Use of a piano wire soldered to a drill shank enables Curtiss-Wright to ream out long hinges fitted on aircraft. Wire is supported by a ¼"-dia. slotted tube, which prevents it from buckling.

NIPPONESE NAVY'S Debut-at-Finale Bombers

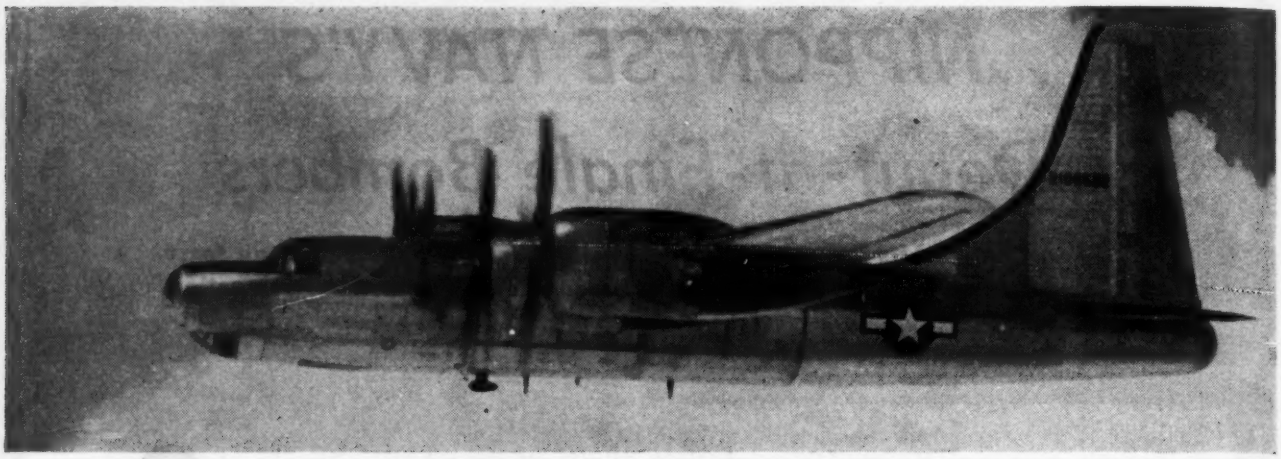
As war entered its last stage, Nips were still frantically building an air force in which Grace 11 and Betty 24 were among new navy craft to see action.



One of Nip's latest torpedo-bombers was Aichi Ryusei 11 (Grace), a two-or-three-seat inverted-gull-wing navy craft powered by an 1,800-hp. Nakajima Homare 11 twin-row engine. Designed for carrier operations, plane's top speed was put at about 350 mph. Landing gear folds inward, and it is believed that outer wing panels fold upward for storage. Span is estimated at about 47 ft., and length at about 37 ft. Armament consists of 20-mm. cannon and 7.7-mm. machine guns. Jap name Ryusei means Shooting Star. (Aviation staff sketches)



Mitsubishi 24 (Betty) is another modification in type that has long been used by Japs for all types of operations. Changes included new nose, with more transparency, also four-blade propellers, and upper gun turret believed to mount a 20-mm. cannon. Protruding "feeler" at nose is for airborne radar equipment. Earlier versions of Betty were being used for transporting both men and materiel. Power plants are Mitsubishi Kasei twin-row radials of over 1,800 hp. each. Span is 82 ft. and length 65 ft. Top speed is estimated as about 325 mph. Betty type also played role in carrying Baka flying bomb.



Consolidated Vultee B-32, newest American superbomber which saw action in Pacific theater. Produced by Convair's Fort Worth division, craft has span of 135 ft., length of 83 ft. 1 in., height on ground of 32 ft. 2 in., and gross weight up to 120,000 lb.

Consolidated Vultee B-32 In Last-Round Action

Design and construction details of AAF's newest superbomber are revealed as craft flies against Japs. Featured are extremely high wing loading and auto-synchronized reversible pitch propellers.

ADDING ITS MIGHT to the greatest display of air power ever achieved, Consolidated Vultee's B-32 four-engine superbomber was reported in action before Jap capitulation, permitting revelation of some of its design and construction details.

A high wing monoplane of 135 ft. span, the B-32 is powered by four 2,200-hp. Wright engines turning four-blade Curtiss Electric reversible pitch propellers of 16 ft. 8 in. dia. The reversible pitch propellers make it possible to reduce landing runs by about one third, a fact expected to permit use of smaller fields than would ordinarily be possible for a plane of this size. Just as important, however, is the fact that wear and tear on brakes and tires is materially reduced, thereby cutting down on maintenance and overhaul.

Wing of the B-32 employs a modified Davis foil somewhat like that utilized on Convair's B-24 Liberator, the outer panels especially being quite similar. Following conventional practice, the wing is built up of two spars, metal ribs, and stressed skin. Flush riveting is used throughout the wing.

Fowler type metal flaps, having a maximum deflection of 40 deg., add approximately 30 percent to wing area when in full extended position. Flaps are built in two sections, the inboard section extending out from the fuselage to between engines, the outer section from there to the ailerons. Both sections travel on three tracks and are extended and retracted by hydraulically-operated cables. Aft tips of the engine nacelles, which extend some 2 ft. beyond the trailing edge, extend with the flaps.

The Convair-NACA thermal anti-icing system, first developed for PBY and B-24 types (see AVIATION's Sketchbook of Design Detail, Oct. 1943), is built into the B-32. Under extreme conditions this system will use 1,500,000 Btu. per hr., or enough to heat 25 five-room houses an hour.

Certain sections of the B-32 wing are covered with very heavy gage dural which serves as armor plating for vital spots. Since the chord of the Davis foil is not as great as that of other wing types, and the gross weight of the B-32 runs up to 120,000 lb., wing loading is believed to be more than 80 lb./diagonal ft., at or near the highest loading yet achieved.

Ailerons are of monospar metal construction, fabric covered. Balanced both statically and dynamically, they require no boost system. Trim tabs are electrically operated from toggle switches in the pilots' cockpit, the actuating motors being located at the tabs.

To facilitate maintenance, all engine nacelles are interchangeable and complete power egg changes can be accomplished in 2 hr. This is made possible by a monocoque nacelle structure which attaches to the wing by five bolts. Normal servicing is also facilitated by the nacelle design through such features, for example, as a large door in the upper surface through which a mechanic may enter the accessory compartment to make adjustments.

Air ducts for oil radiators, intercoolers, and superchargers — two for each engine—are built into nacelles below the engine. Since each engine is equipped with two superchargers, the craft's service ceiling is believed to be well over 30,000 ft. Cowl flaps are

electrically operated and jet type exhaust stacks are used, the latter adding 7 to 8 mph. to top speed at altitude.

As is the case in the wing, certain sections of the engine nacelle are built of heavy dural to reduce flak and enemy-fire damage.

Engines of the B-32 are synchronized by the Curtiss automatic synchronizer (see Sept. 1943 AVIATION), which eliminates necessity for constant changing of throttle settings. B-32 is the first craft on which the synchronizer has been a production item.

Main wheels of the tricycle landing gear retract hydraulically up and forward into wells in the inboard nacelles in about 10 sec., with universal-connected tie rods pulling fairing doors closed to completely cover them in retracted position. Main gear uses dual 56-in. tires, and two brake systems are provided—normal hydraulic and emergency hydraulic.

Nose gear is a co-rotating Convair-developed type with dual 39-in. wheels splined to a common axle, with the axle turning on two bearings in the oleo knuckle. This design prevents shimmy without requiring use of shimmy damper and torque links.

Landing gear can be lowered by any of three systems: Normal hydraulic, emergency motor-driven hydraulic system, or by a hand pump.

Fuselage is 83 ft. 1 in. long with a circular cross section having a maximum dia. of 9 ft. 6 in. Approximately 1,000 lb. in weight was saved by the use of artificially-aged aluminum, (first reported in AVIATION in Aug., Sept., and Oct. 1943). Flush riveting is used on the fore part of the fuselage, conventional brazier-head rivets being employed aft of the pilots' compartment.

Quarters for bombardier, pilots, aerial engineer, avigator, and radio operator are all forward of the leading edge of the wing, and another cabin aft of the dual tandem bomb bays is provided for other crew members. In both cabins, Convair-developed lightweight glass fiber soundproofing is installed.

Bomb bay doors are similar to those developed for the B-24 — aluminum alloy sheet backed by hat-shaped stiffeners rolling up alongside the fuselage on tracks by means of hydraulic jacks. A heavy built-up beam running the full length of the bottom of the bay also serves as a cat-walk between cabins.

The full cantilever stabilizer, built as a complete unit, is attached to the fuselage by bolts attaching to built-up channel section formers inside the fuselage. Metal fabric-covered elevators follow conventional construction and have combination trim and servo tabs which are cable operated.

The single vertical fin is of unusual height — its top is 32 ft. 2 in. above the ground when the plane is in taxi position — giving such stability that it is reported the craft can be kept on course with minimum difficulty even with both engines out on one side. The fabric-covered rudder is mounted on three hinges and has trim and servo tabs.

Armament details may not be released, but it may be assumed that the B-32 is at least as well armed as other American bombers, which would mean a minimum of at least ten 50-cal. machine guns. It is understood that no central fire control system is employed.

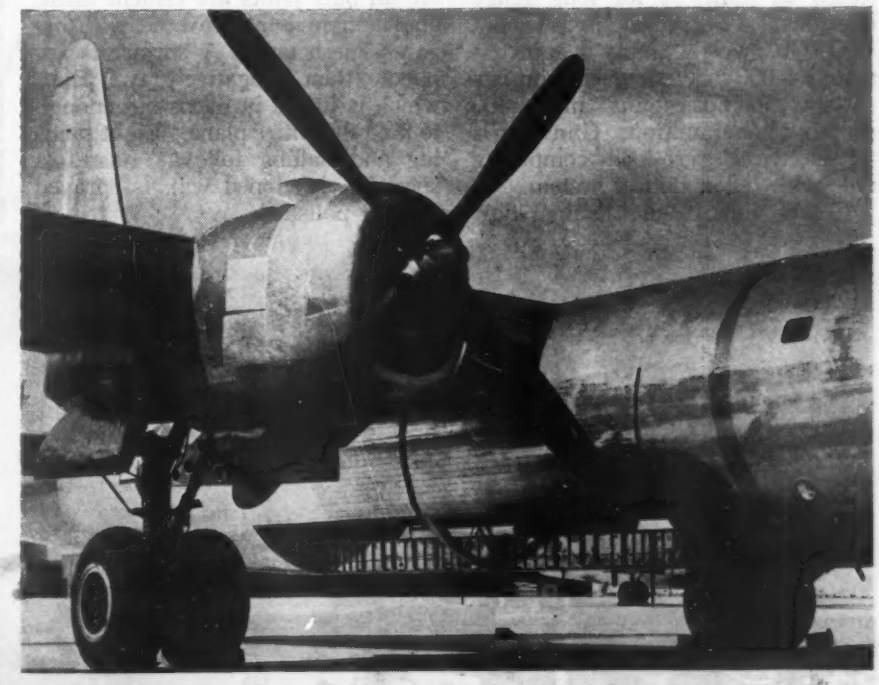
Production is now concentrated at Convair's Fort Worth, Tex., division, with the contract scheduled for completion around the end of this year. Here much the same production system employed for B-24's is being utilized; in fact many of the work stands used on the moving final assembly line have been re-employed with only slight modifications to take care of the difference in size of the two planes. And, as is becoming the rule in American aircraft production, combat-dictated modifications are being made right on the production line.

Nuclei of the flight crews were given streamlined transition training by the AAF Technical Training Command, headed by Lt. Gen. Barton K. Yount, at the Fort Worth Army Air Base, on the opposite side of the field from the Convair plant.

Here the Air Commander (new name for the pilot), Pilot (new name for co-pilot), and Aerial Engineer (who used to be called flight engineer) were welded into a team during the 80 hr. of flying time given at this base. Since the pilots all average about 1,000 hr. of four-engine bomber time before reaching the base, this apparently low time was found sufficient to train them on the new craft.

Upon completion of the flying and ground school transition work, the crew nucleus then proceeded to an advanced training base, where the remaining five men of the crew were brought together for final training.

Unusual size of B-32's single fin is said to give such stability that craft can be held on course with minimum effort even though both engines on one side are cut out. Fabric-covered rudder has area of 70.5 sq. ft. aft of hinges, including 6.8 sq. ft. of trim and servo tabs. Area of fin and rudder is 236 sq. ft.



Detail photo shows main beam extending length of dual tandem bomb bays, doors of which are same type as employed on Consolidated B-24. Landing gear, having dual 56-in. wheels, retracts forward and up into nacelles. Reversible pitch Curtiss Electric propellers reduce landing runs about one-third.

That Zipping Lockheed P-80

CREDITED WITH AN "OVER 550 mph." top speed, Lockheed's P-80A Shooting Star is so sleek that it looks more like a wind tunnel model than an airplane just off a production line.

Powered by G-E's super jet turbine, the craft's ceiling is given as over 45,000 ft., and fuel capacity is stated as sufficient for long range missions. Gross weight is about 14,000 lb.; weight empty is approximately 8,000 lb. Armament consists of six .50 nose guns and 1,800 rounds of ammunition. Gunsight is an electrical gyro-load computing type with reflex optical system.

Center line of the laminar-flow wing is only 2 in. behind the fuselage midpoint. The craft has a hydraulically-operated retractable tricycle landing gear. Droppable wing-tip tanks, mounted on inner shackles, give the P-80A a weird aspect.

Special finish is obtained by cutting and surface grinding all rivets. Then a zinc-chromate primer is put on, all butt joints are cement filled, and flexible joints covered with organdy-mesh tape. A surface is applied, then negative-gray paint, which is baked in ovens big enough to hold the entire plane. Light sanding and buffing follow. Lastly, a specially developed wax is sprayed on and polished.

Closeup of P-80A's nose (below—left) shows details of air intakes, tricycle landing gear, and armament. Photo at lower right depicts jet exhaust nozzle set below the tail surfaces. Fuselage aft section, including nozzle, is removable by detaching three fittings and tail pipe clamp. It is stated that a complete engine-change takes less than 20 min.

Specifications and Data

Span	38 ft. 10½ in.
Length	34 ft. 6 in.
Height	11 ft. 4 in.
Area (control surfaces)	31.6 sq. ft.
Gross weight	about 14,000 lb.
Empty weight	about 8,000 lb.
Top speed	over 550 mph
Ceiling	over 45,000 ft.
Power plant	One G-E jet-turbine

Artist's conception of Convair's newly-designed 30-passenger Model 110 transport. Seen here is forward loading hatch, with passenger entrance at tail. Planned payload of craft is 8,000 lb., and estimated top speed is 322 mph. Tricycle landing gear with dual wheels, Fowler type flaps, and four-blade reversible pitch propellers are to be installed. Note gull wings and truncation at rear of engine nacelles.

CONVAIR COMING OUT WITH TWIN-ENGINE AIRLINER

Of medium size, transport craft is specifically intended to meet airline needs, with company engineers placing emphasis on ease of travel for the passenger as well as economy of operation.

A 30-PASSENGER POSTWAR SKYLINER, specially aiming to accent both passenger comfort and operating efficiency, has been planned by Consolidated Vultee.

Meeting ATA specifications, the new design, designated Model 110, is to be powered by two 2,100-hp. P&W Double Wasp R-2800 engines, which are to give the plane an estimated top speed of 322 mph., a 275-mph. cruising speed, and a stalling speed of 79 mph. Maximum range, at 265 mph. with a 6,600 lb. payload, is given as 850 mi. The craft's gross weight is to be 32,300 lb., with empty weight at 20,680 lb.

Wingspan is to be 91 ft., length 71 ft., and wing area 820 sq. ft. Wing loading is estimated at 39.4 lb./sq. ft. Fowler-type flaps are to be fitted, and the four-blade propellers are to be of the reversible-pitch type for use as brakes in landing. Tricycle landing gear, with dual wheels, will be completely retractable.

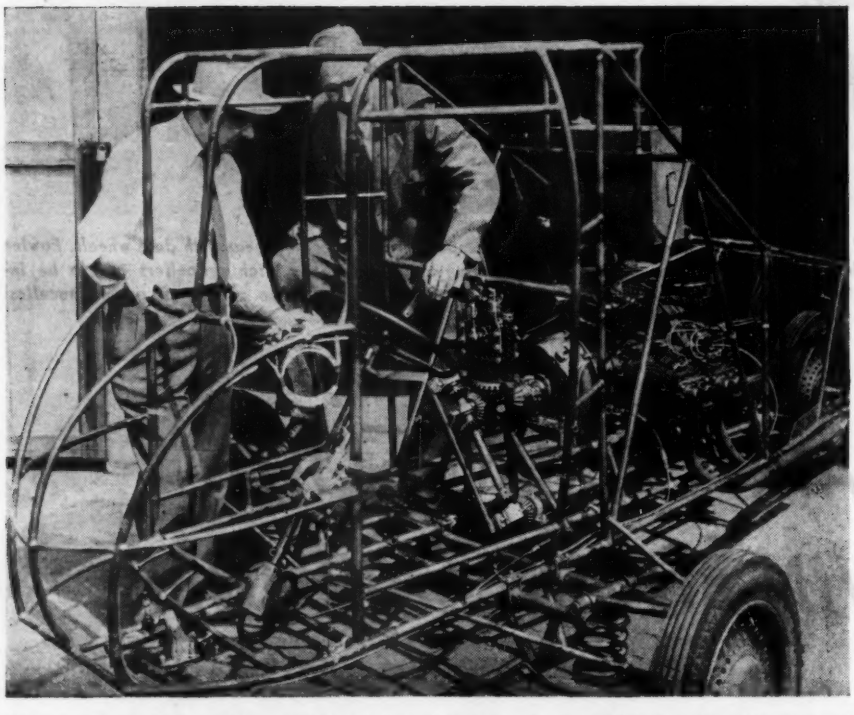
Interior arrangements for the craft are being planned by Henry Dreyfuss, industrial designer. Interior features, it is stated, will include individually adjustable Polaroid windows to reduce glare, spun-glass insulation, and adjustable headrests for the custom-designed seats. Cabin is to be finished in restful colors.

Passengers will leave and enter the plane by way of a retractable stairway located beneath the tail. At the head of these stairs will be luggage racks and a full-height coatroom.

Specifications and Data

Span	91 ft.
Length	71 ft.
Wing area	820 sq. ft.
Wing loading	39.4 lb.
Gross weight	32,300 lb.
Empty weight	20,680 lb.
Top speed	322 mph.
Cruising speed	275 mph.
Stalling speed	79 mph.
Maximum range (265 mph. with 6,600-lb. payload)	850 mi.
Service ceiling	29,100 ft.
Operational ceiling (one engine)	16,100 ft.
Required CAR runway length for takeoff (sea level)	2,900 ft.
Flaps	Fowler type
Propellers	Four-blade, 12 ft. 2 in. reversible pitch
Power	Two 2,100-hp. P&W Double Wasp R-2800; gear ratio, .45
Seats	30

C. W. Industries 'Copter Is Two-Place Roadable



Closeup view of Flymobile roadable helicopter shows fuselage detail, also placement of Franklin engine and gears. Designer Kay (right) has his hand on lever which drops rotor-driving gear into mesh with power shaft in front of clutch. Rotor shafts and blades have not yet been installed. Curtis Wright is standing at left.

West Coast concern brings out co-axial utility craft containing some novel design features. Among these are gimbal ring system for tilting of rotors and differential pitch control actuated by foot pedals.

STATED TO BE THE FIRST roadable helicopter built, the Flymobile is a special design by Dr. E. E. Kay and Curtis Wright, of Curtis Wright Industries, Los Angeles. Particular attention was given to the problem of building the rotary craft in small size for suitability as a two-place roadable vehicle.

During preliminary calculations it was determined that a 1,200-lb. gross weight and fuselage measurements of about 40 in. wide and 150 in. long were feasible as first data for the Flymobile design. The co-axial type, it was assumed, would best combine good flight qualities with roadability. Accepting the maximum load at 14 lb./hp. a 90-hp. engine was selected.

Co-Axial Helicopter

Fuselage construction is of steel tubing covered with fabric. The Franklin four-cylinder opposed engine is mounted behind the seat and fan cooled. Adjustable seat, curved instrument panel, and upholstering are all finished in a dark cherry color. The rotor blades, which have a span of about 26 ft., are fastened to the rotating shafts through tubular hubs, inside of which the blades roll on ball bearings. These hubs are rigidly connected with the rotor-carrying shafts, which are placed 19 in. apart between their centerlines. Projected blade area is .041 of disk area.

Blades are of symmetrical NACA 0015 airfoil section and each has a steel tubing spar, spruce edges and birch plywood ribs, covered with laminated plastics. The blades taper in width and thickness, each rotor having a total area of 21.45 sq. ft. Weight of each rotor including bearings is 46 lb. 8 oz. With disk area (S) equal to 520 sq. ft. and total thrust (T) of 1,200 lb., a disk loading (T/S) of 2.3 lb./sq.ft. is attained. At a blade rotation of 300 rpm., the tips are moving at about 285 mph. Ratio between the engine and rotor shaft is 1:7.5.

Control in transferring engine power from roadability to flying or to a neutral position is accomplished by swinging a lever located just behind the seat. Due to eccentricity, this lever raises or lowers a bearing housing carrying a bevel gear which is meshed with another pinion mounted on the engine shaft. By turning the

lever to the right and thus lowering the bevel, the engine power is transferred to a vertical shaft leading to the main gear box, and from there it goes to the two opposite shafts carrying the rotors. The leading shaft is provided with two universal joints and a spline, which is stated to permit rotation during tilting of the rotor shafts in any direction within 360 deg.

Tilting of the rotor shafts is done on a gimbal ring arrangement fastened to the main gear box, the outer ring being connected to the fuselage. Such an arrangement is said to serve three purposes: 1. To give effective stability, especially lateral; 2. to give flexibility to the rigidly attached rotors; and 3. to utilize inclination for automatic change of the angle of the wobble plates and, subsequently, of the cyclic pitch.

Simultaneous change of pitch for ascending or descending is achieved by a separate lever located just below the cockpit ceiling. By moving this lever upward, sleeves sliding on the neck of the main gear box move accordingly, carrying with them the wobble plates. The latter are connected by links and rods to the blades.

In addition to performing simultaneous change of pitch control, the control also includes differential change of pitch control between the upper and lower rotors, this provision being necessary in order to control rpm.'s and to facilitate the craft's maneuverability. Differential control is worked by broad foot pedals, behind clutch and brake pedals, and is one of the Flymobile's more interesting features. Pushing the right pedal increases the pitch of the lower rotor blades uniformly to a degree indicated by foot pedal pressure.

The added lift and load, on the lower rotors (which provide only 25% of the craft's total lift), removes a measure of torque neutralization and swings the fuselage to the right until pedal pressure is removed. Similarly, by pushing the left pedal, lower rotor pitch is decreased and reverse torque turns the fuselage to the left. Coordination of wheel column and pedals gives change of both flight and fuselage direction.

Attached to the differential pitch control arm at the lower rotor is a supplemental linkage which allows a very slight reduction of pitch and lift of the upper rotor when the right pedal is depressed, and an increase of pitch and lift when the left pedal is pushed. Devices on the steering wheel and steering gear permit coordinated movements between the steering wheel and rotor shafts. Turning the wheel to left or right, or moving it forward or backward causes the rotor shafts to tilt accordingly, and the craft moves in the direction of tilt. Any movement of the wheel is stated to give a positive result due to the action of worm gear, and it is also claimed that the craft can be flown hands off.

Automatic change of the wobble plates' angle (cyclic system) is done by a specially designed connecting link between the unrotating part of the wobble plate and the fuselage frame. This link is free to follow upward and downward movement. It also pulls the wobble plate in the opposite direction from the line of shaft's tilting and, at the same time, causes the wobble plate to be inclined in accordance with the direction of flight.

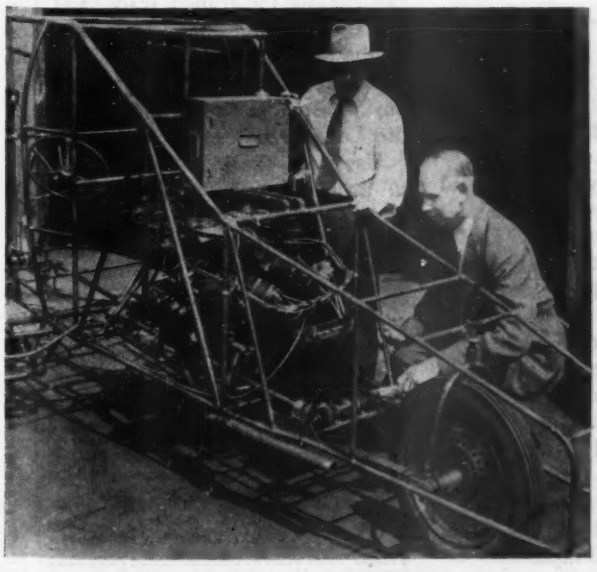
As a Roadable Vehicle

Designed for roadability without interfering with traffic, the fuselage is shaped like a small car and is mounted on three 16 x 14 in. wheels—two in front and one in the rear. The front axle is placed on coil springs, allowing knee action. The wheels are connected to the axle knuckles through the hydraulic brakes, and control is by the Ackerman system of steering arm, rods, gear, and steering wheel, with the exception of some devices attached to the steering wheel and gear which permit using the wheel as part of the 'copter's controls.

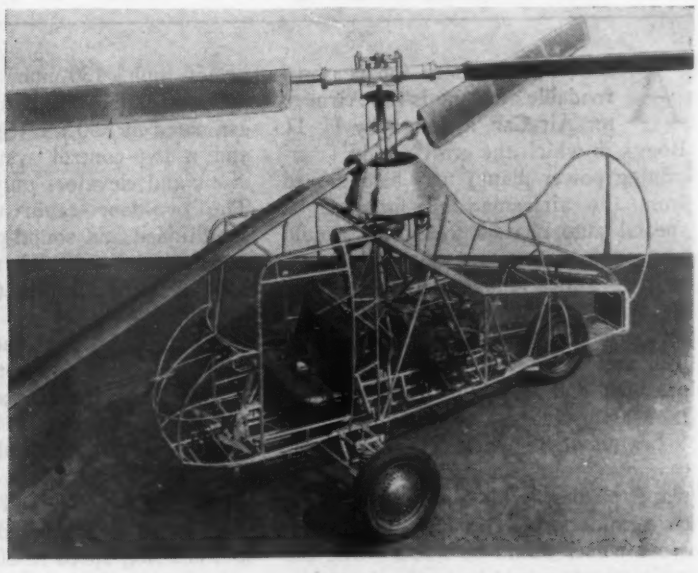
The rear axle, carrying the drive-wheel and sprocket, is connected with the frame by two leaf springs. Engine power is transmitted to the wheel by means of shafts, gears, sprockets, and chain.

Because the total engine power is also used for roadable driving (in comparison with the actual need for only 8 hp.), and to save weight, it was deemed best not to install a speed transmission box. There is a provision for reverse driving. It consists of a sliding sleeve with two gears at each end. Each gear can be engaged with a pinion mounted on the engine shaft. The control lever for this drive is located in front of the pilot's seat.

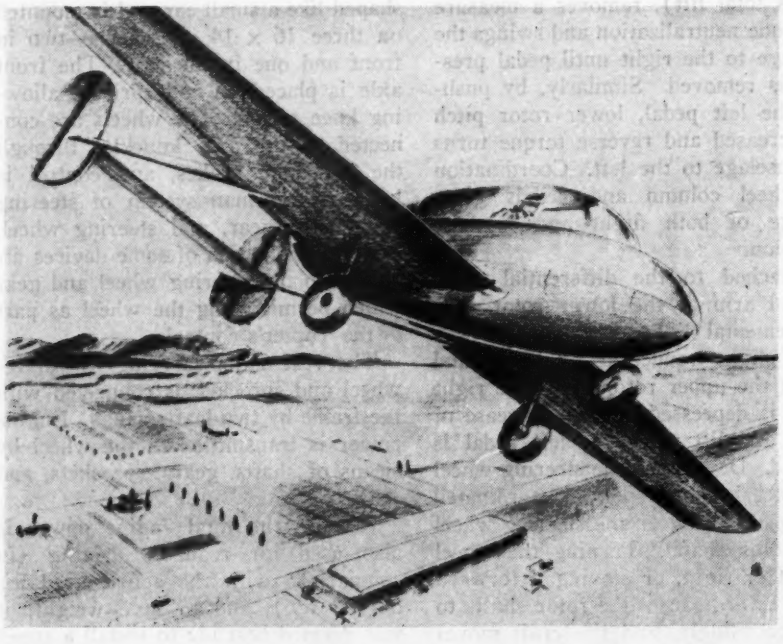
Speed of the ground vehicle is regulated by throttle. Top speed of the craft on the road is given as 56 mph., using maximum engine rpm. Engagement and disengagement are done via a clutch installed on the engine shaft and regulated by the left foot pedal. The right pedal controls the front wheel hydraulic brakes as well as the main vertical shafts carrying the rotors.

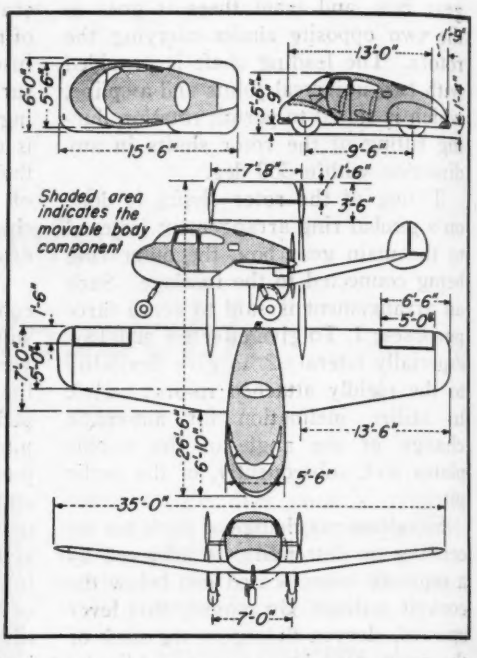


Left: Flymobile's roadable drive gears and chain are pointed out by Dr. Kay. Total engine power is also used for roadable driving. There being no gearing down, craft's land speed is controlled by throttle and clutch. Top ground speed is estimated at 56 mph.



Right: Helicopter uncovered. Above seat (left) is lever for controlling rotor pitch. Broad foot pedals operate differential pitch. Coordination of both steering wheel and foot pedals is stated to give both change of flight direction and to aim fuselage accordingly.





Sketch of Boggs Airmaster Air-Car shows pusher engine, twin tail booms, and tricycle landing gear design. Seating four, top speed is estimated at 150 mph., and range at 500 mi. Seen for the automobile version is at top speed of 105 mph. Craft is to be fitted with sound-proofing and air-conditioning. It is stated that changing detachable body from car chassis to plane chassis would take less than 5 min.

Four-Place Air-Car Is New Roadable Project

Designed for high performance, pusher craft would provide air-ground transportation through employment of detachable body which may be used on either plane or car chassis.

A NEW APPROACH to the personal roadable airplane is the Airmaster Air-Car, a design by H. D. Boggs in which the craft's body (containing power plant) may be removed from the airframe and fitted on a special auto chassis to afford ground transport.

It is stated that plans are being formulated for construction of a prototype of the vehicle this coming Fall. The designer is assistant to the vice-president and general manager at Glenn L. Martin-Nebraska Co., Omaha.

Layout of the Air-Car as a plane is that of a four-place, low-wing monoplane pusher, with twin tail booms, twin rudders, and tricycle landing gear. Nose wheel would be fixed, while the main wheels would be semi-retractable. A 145-hp. geared drive engine cooled by air (fan assisted), would be used, giving the craft an estimated top speed of 150 mph., 130-mph. cruising speed, and a 53-mph. stalling speed. Range is estimated at 500 mi. Spinproof wings and a two-control system (with ailerons and elevators only) are planned The two-door cabin would be air-conditioned and sound-proofed. Landing gear nose wheel is to be steerable, and wheel brakes are to be standard equipment.

Features of the automobile would be: All hydraulic drive (motor to each rear wheel), automatic gear shift, individual suspended wheels, air-conditioned cabin, streamlined body, rear drive engine, five passenger capacity, with 112-in. wheelbase and 66-in. tread. Top speed is estimated at 105 mph., and cruising speed at 80 mph.

It is stated that it would not be necessary to unhook flying controls, fuel lines, and the like. Conversion time from plane to car, or vice versa, is estimated would take 4 min. and be done in three operations—body lock or unlock, propeller removal or mounting, and connecting or disconnecting of car's transmission.

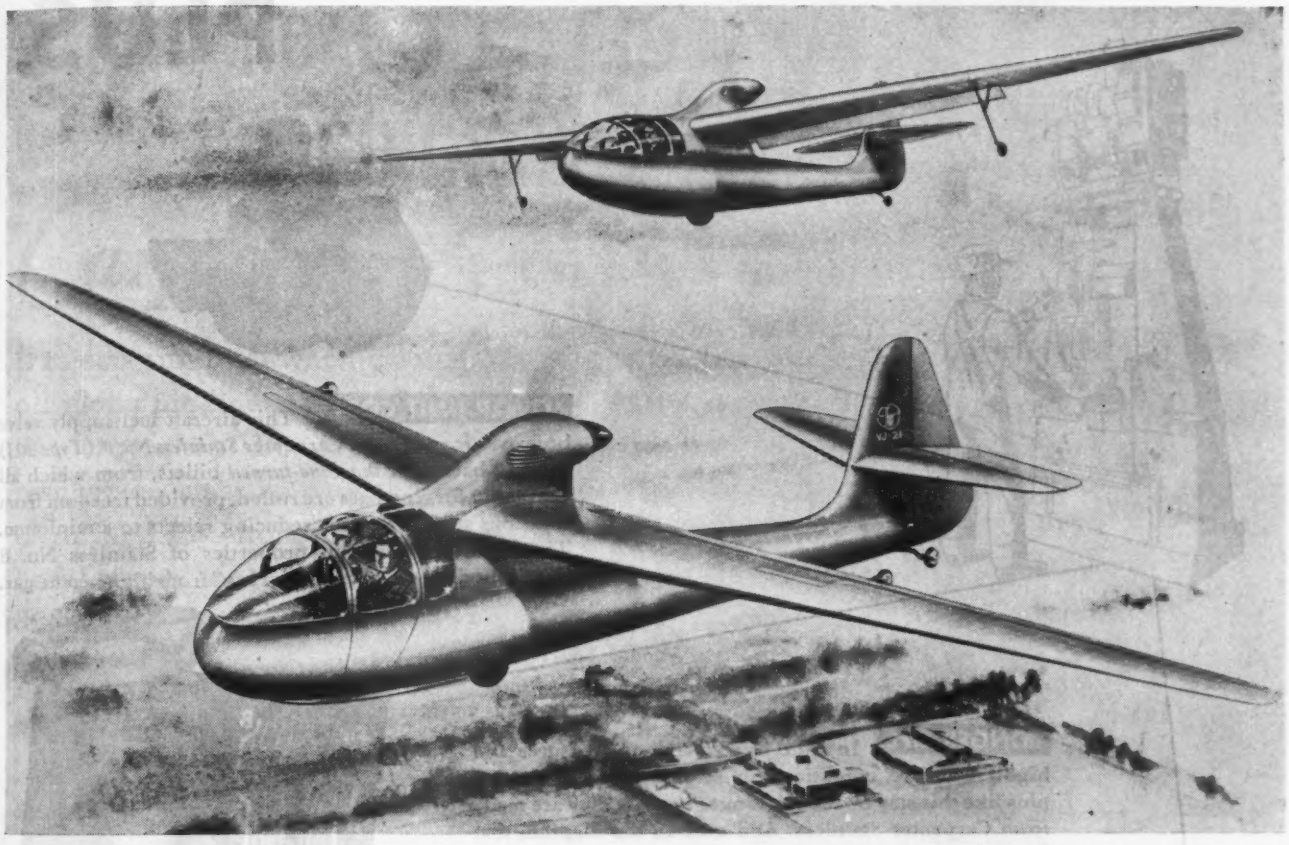
Designer Boggs is of the opinion that the first market for the Air-Car would comprise district sales managers, salesmen with large territories, professional men, and service men. Agencies would provide rental services of car chassis for transit trade, and also rental of airplane chassis in some cases. In the beginning, these agencies would be located in about 47 cities throughout 38 economic geographic centers of the United States.

Users of the Air-Car could drive to a nearby airport, convert to the airplane chassis, fly to a destination, and on landing, convert again to a rented car chassis for ground travel. At home the car could be used on customary traveling, while the airplane chassis was stored at the local airfield.

No estimates as to weights, prices, or operating costs of the Airmaster Air-Car are given.

Specifications and Data

Span	35 ft.
Length	26 ft. 6 in.
Tread	7 ft.
Propeller diameter	84 in.
Top speed	150 mph.
Cruising speed	130 mph.
Stalling speed	53 mph.
Range	500 mi.
Seating	Four
Power	145-hp. air cooled



Jarvis VJ-21 reflects much of its designer's sailplane experience. Powered by a 65-hp. engine, and seating two side-by-side, it is stated craft will have 135-mph. top speed, cruise at 110 mph., and have a range of 400 mi. New-type monoped landing gear is to be fitted, and wing wheels are to retract. High aspect ratio wings will have flaps and spoilers. Construction will be all metal.

Jarvis Firm Introducing VJ-21 Two-Placer

New personal plane, designed by sailplane expert, is a side-by-side pusher, featuring new-type landing gear. Scheduled for flights this month, craft is tentatively priced at $2,000.

UTILIZING many principles of sailplane design, the new Jarvis VJ-21 is a two-place side-by-side personal plane designed by Volmer S. Jensen and now under development by Jarvis Mfg. Co., of Glendale, Calif.

Stated to incorporate many new, but not radical features, the VJ-21 is to be of all-metal monocoque construction. One of the craft's more unusual features will be a four-wheel landing gear, with the main gear arranged as a monoped, plus a steerable, fixed tail wheel and two retractable auxiliary wing-wheels halfway out to the wingtips. The main wheel, placed 2-in. in front of the most forward position of the C. G., is to be fastened directly to the main bulkhead with no shock-absorbing strut. To protrude 8 in. beneath the fuselage, it will not be retractable, but will have a conventional brake operated from the cockpit.

Additional braking is to be possible by nosing the craft down slightly, after landing, onto a 3-in. steel nose-skid. The two wing-wheels, when down, and the main wheel are all to be in the same line laterally.

Of full cantilever design, the wings are to be fitted with flaps and spoilers. Span is to be 42 ft., with chord tapering from 5 ft. at the fuselage to 2-ft. at the tips. NACA 2418 to 4412 modified airfoil sections are planned. Wing area is to be 158 sq. ft., wing loading will be 8.5 lb./sq. ft., and an aspect ratio of 13 to 1 is to be used.

The cockpit is to be 42 in. wide, and conventional stick and three-movement controls are to be fitted. Because of the planned position of the 65-hp. engine as a pusher behind the wing, a maximum degree of visibility will be possible. The pusher design is seen lessening noise during flying, also obviating propeller wash when entering or leaving the cockpit, and the rear, high position of the propeller will afford safety for spectators.

A prototype of the Jarvis VJ-21 is expected to be flying this month. Price has not yet been determined, but it is stated it will be around $2,000.

Specifications and Data

Span	45 ft.
Length	24 ft.
Wing area	158 sq. ft.
Wing loading	8.5 lb./sq. ft.
Empty weight	850 lb.
Gross weight	1,350 lb.
Top speed	135 mph.
Cruising speed (70% of power)	110 mph.
Landing speed	40 mph.
Stalling speed	35 mph.
Rate of climb (sea level)	700 fpm.
Service ceiling	16,000 ft.
Range	400 mi.
Seating	2 side-by-side
Power	65 hp.
Prospective price	$2,000

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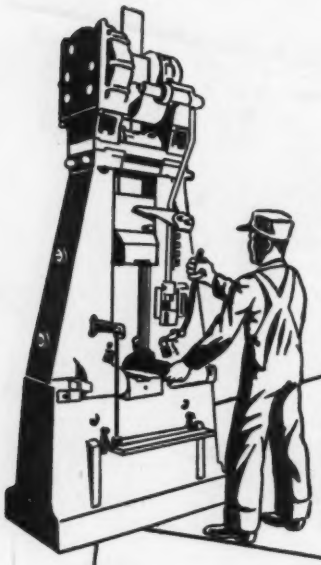
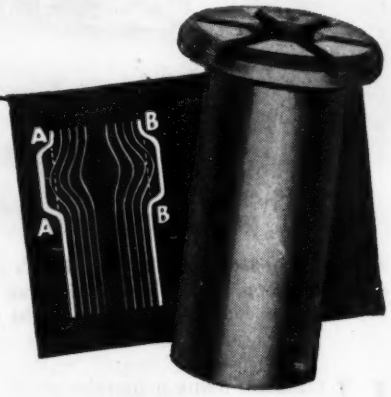


LOWER UNIT COSTS. This aircraft fuel supply valve body was forged from Carpenter *Stainless No. 8* (*Type 303*) forging bars. Our *machine-turned* billets, from which all Carpenter forging bars are rolled, provided freedom from injurious surface defects, reducing rejects to a minimum. The corrosion resistant properties of Stainless No. 8 licked the danger of "valve sticking" from high octane gas.

LONGER LIFE. In spite of tremendous pressures and highly abrasive conditions in service—forged knuckle pins like this stay on the job longer because they are made from Carpenter Stainless. And note in the diagram that forging produced an even grain flow throughout, thus strengthening the thin sections at points AA and BB.



POSITIVE PROTECTION against corrosion to withstand the effects of repeated sterilization plus the required strength and hardness, made Stainless a natural choice for these forged surgical instruments. Clean, flawless Carpenter Stainless forging bars reduced rejects, increased output.

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PARTS PRODUCERS CLARIFY DISTRIBUTOR-DEALER DISCOUNTS

By JOHN FOSTER, JR., *Managing Editor, "Aviation"*

Survey by AVIATION not only shows the trend in margins for those who move aircraft parts and accessories, but reveals what producers feel is required in the way of financial reserves, advertising, and sales promotion.

AS THE AIRCRAFT INDUSTRY returns to competitive, more-than-one-customer peacetime operations, the discount problem assumes major importance. To help clarify a badly confused picture for actual and potenial distributors and dealers—and many manufacturers too—AVIATION has just conducted a nation-wide survey to determine what discount policies may be expected in the distribution of aircraft parts and accessories.

From the replies received from a cross-section of the industry, two basic facts emerge:

1. Sale of aircraft parts and accessories will reach the ultimate consumer through a basically simple system extending from the manufacturer through the distributor, to the dealer, to the customer.

2. Distributors will have to plan their operations to work on discounts of approximately 50% off list prices; dealers will operate on margins of just about 25% off list prices.

Obviously, there will be variations, but at least from the producers' standpoint, this will be the immediate post-war pattern. There is, for example, some variation in the actual definitions themselves, but a composite of the industry gives these:

The distributor is one who performs these functions: carries an inventory adequate to promptly serve the dealers in his territory; has salesmen actively contacting the dealers; does advertising; and, in many cases, extends necessary credit to dealers.

In some cases the organization performing most or all of these functions is called the wholesaler, in others it is sometimes referred to as the jobber.

The basis for establishing a distributorship also varies somewhat, as would be expected. In the case of one manufacturer, for instance, an aircraft distributor is defined as an organization holding a contract with an airplane manufacturer that has produced at least 100 new planes.

In another instance an aircraft parts distributor is defined as an organization holding no contract with that particular manufacturer, but whose principal business is selling—either wholesale or retail—airplane and engine parts and accessories to manufacturers or users, and whose volume of business exceeds $10,000 annually. In practically every definition, however, the words "fixed base operator" or "aircraft service operator" appear.

Prime requisite for the dealer, it appears, is that he carry an inventory adequate to give prompt service to the ultimate consumer. Some manufacturers, though, require their dealers to do specified amounts and types of consumer advertising and sales promotion, either through local or trade advertising, issuance of catalog or direct mail promotion.

Here, too, exact definitions vary considerably, but almost all the way through the industry, these definitions include fixed base operators, aircraft service operators, and, in a good many cases, flying schools.

It seems quite certain that there will be few, if any, sub-jobbers—those between the distributor and dealer—in the aircraft parts and accessories distribution chain, for manufacturers are almost unanimous in agreeing that this function is not now and will not be necessary for orderly, economic sales.

One sales manager, as an example, reported he feels "this sub-jobber picture is over-emphasized at this time, and I really can't see a place in the picture for such a discount, unless it be for a very large operator in a territory that is somewhat remote or out of the way where he can service some small operators."

Allowing the sub-jobber discount has, in fact, been cited as a price-cutting scheme which is dangerous not only to the manufacturers because of the trend it starts, but to the sub-jobbers themselves who may find their organizations loaded with large inventories which they will be unable to move, especially if the parts and accessories involved become obsolete.

Although manufacturers are perennially under pressure from all links of the distribution chain to increase discounts, there is little evidence at present to indicate they will soon be greater than the 20–25% to the dealers and the plus or minus 50% to the distributors.

As one company, whose discounts are very close to these averages put it; "our policy has worked out very well in practice and is, we believe, realistic, since it grants the maximum possible discount on which a manufacturer can show a profit on today's volume. It gives the dealer, who is basically a retailer, a 30% discount which is considered necessary for a profitable retail operation. It gives the distributor a maximum 20% spread which also is necessary for a profitable wholesale operation. Possibly when the aircraft market expands, a wider total discount spread will be possible due to lower production costs, and in that event there will be room in the setup for the sub-dealer or sub-distributor. At the present time we do not think that is sensible."

Another very large manufacturer,

planning to expand its aviation activities, reported that "it is only human nature to try for the longest profit possible on the purchase of merchandise for resale, but when the airplane operator-dealer and private-end user begin to realize they are not distributors and when distributors begin to enforce a policy of upholding suggested retail and dealer prices to those customer categories, I believe much of the confusion that seems to exist will be relieved."

Further evidence that discount ranges will be difficult to change immediately comes from a third manufacturer who points out that "during the past year or so we have been deluged with inquiries from would-be distributors all over the country. In seven cases out of ten these inquiries originate from sources that could under no circumstances be considered legitimate distributors. It seems that every shop with two or three airplanes to repair is attempting to chisel out the largest discount possible. Only a steadfast position by manufacturers can hold the line and prevent development of a chaotic situation for all concerned. If discounts are confined to those legitimate outlets entitled to them, then chaos can be prevented."

The right to sell direct to airframe and engine producers will almost certainly continue to be retained by the parts and accessory manufacturers and in some cases to airlines, the study revealed.

As between the parts-and-accessory manufacturer and the aircraft manufacturer; one concern allows the manufacturer a discount slightly greater than that given distributors, but the aircraft producer is required to specify whether the material is for original equipment or for resale to the plane distributors. In the latter event, the discount allowed is the same as that given the accessory producer's own distributors. This manufacturer will give the airframe producers discounts only on the same items which are purchased for original equipment.

Most parts and accessory manufacturers retaining the right to sell direct to airlines have not revealed the discount schedules, but it is interesting to note that one has already made plans for discounts to both large and small feeder lines, keeping them in a category separate from trunklines.

Methods of appointing distributors and dealers very considerably as to detail, but in every case involve a pretty thorough-going investigation, at least for distributorships. And in every case, whether the investigation be done by simply having the prospective distributor fill out a form or by more complex methods, the $64 question is on the applicant's financial record. This, it is almost unanimously reported, is going to be rough on a great many people who want to be postwar aircraft, parts and accessories distributors, but adherence to a policy of demanding financial stability will save money not only for the manufacturers themselves, but for many who would like to get into the aircraft business.

Those already in the business and planning to take on additional lines, and those not now in the business but planning on entering, can almost certainly figure on answering a great many pertinent questions. A composite of questionnaires and instructions to investigators shows that manufacturers want salient facts on these major points:

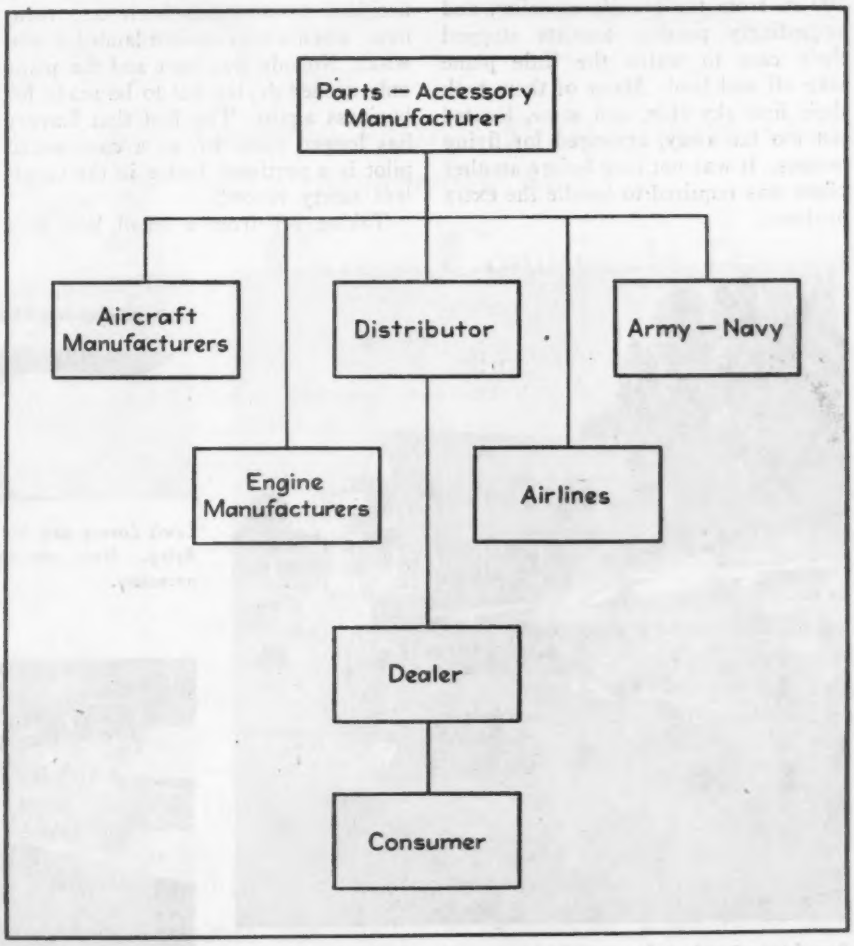
Personnel — Some manufacturers want information on all top men; others require data only on key personnel, usually including sales managers and buyers.

Type of operation—This gives clues to the possible business volume which might be developed for the particular line. In some cases manufacturers want information on the organization's setup—if the applicant is a corporation, partnership, etc.—and just where its control is held.

Size of the company—This will include the number and, in many cases, skills of employees; number of aircraft operated; and the types of organizations with which the applicant does business. Sometimes this latter information must be in considerable detail, either in percentages or in gross monthly volume.

Advertising and promotion — In nearly every case the manufacturer wants to know not only how much advertising and promotion has been done, but how and where it was done. Others want complete descriptions of sales and other equipment.

Finances—Every manufacturer wants unequivocal information on this point, whether it be presented in the form of financial statements or through references. Such information is, they report, an absolute essential if the industry is to avoid many of the pitfalls which retarded its growth prior to the war.



Here's how majority of aircraft and accessory manufacturers believe bulk of their production will be distributed. Most merchandise will move in direct line through distributors and dealers to ultimate consumers, with possibility of jobbers and sub-jobbers held remote until industry reaches high volume. Most manufacturers will continue to sell direct to airframe and engine builders, large airlines and government.

Village Floatplane Base Pays Off

Can the small, outlying flying-service really turn a good profit? "Yes," is Lewis Lavery's answer. For starting eight years ago with just a two-cylinder seaplane and an auto-trailer "base," he now owns four aircraft, together with a fine clubhouse which is also headquarters for a live-wire seaplane club.

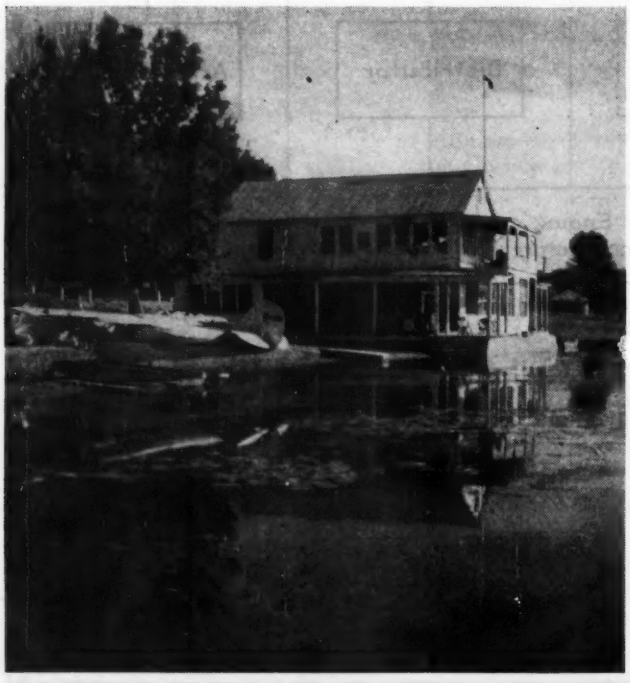
IN 1937, LEWIS LAVERY parked his auto trailer at Round Lake, N. Y., just north of Albany. And with this "base of operations" established, he then brought in his C-3 Aeronca seaplane. Next day, the Lavery Seaplane Service commenced business, flying "dollar hops."

The Saratoga highway ran less than 100 ft. from the plane's mooring, and accordingly passing tourists stopped their cars to watch the little plane take off and land. Many of them took their first sky ride, and some, located not too far away, arranged for flying lessons. It was not long before another plane was required to handle the extra business.

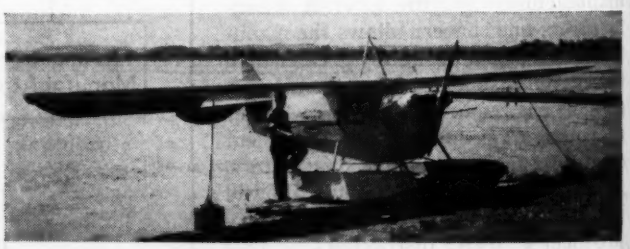
Then came the war. But business continued to grow nevertheless because the Army did not require this small seaplane base and the lake was not large enough to suit the Navy, hence civilian pilots continued to be turned out. The safety record was good, because, as Lavery states, "water is a lot softer to land on than land." Only accident to date has been one turnover, when a solo student landed downwind. Nobody was hurt and the plane only needed drying out to be ready for business again. The fact that Lavery has logged 3,200 hr. as a commercial pilot is a pertinent factor in the excellent safety record.

Taking off from a small lake is a neat trick, but seemingly not too hard to learn, since nearly 100 students have so far obtained their licenses at this base. As soon as the floats commence to rise onto the surface of the water, the plane, still traveling straight forward, is banked until one float is entirely clear of the surface. This reduces the drag sufficiently to permit a considerable rise in speed, whereupon the plane is leveled off, raising the other float out of the water and causing the plane to be airborne in a much shorter distance than by conventional methods.

Starting with one plane, Lavery now owns three, the latest addition being a Waco YKC. He also has the Aeronca sales agency and handles Edo floats. As a natural sideline at a lakeside base, he owns a fleet of boats for use in the fishing season, Round Lake being well stocked with bass and other fish. Round Lake Seaplane Club has its headquarters in his building. And the ample porch, on both front and sides of the structure, provides a comfortable and roomy meeting place for those who are not flying.



Round Lake Seaplane Base and Clubhouse. Though lake itself is open, water around landing is sheltered from prevailing winds, making safe anchorage. Lower part of building comprises lunch room, office and repair shop, with large front veranda which also serves for fishing boat landing.



Lewis Lavery and his Aeronca C-3, still active after eight years of flying. Note concrete block anchorage, reliable and movable if necessary.

Aeronca Chief at dock. Pipe at edge of dock conveys fuel from pump directly behind plane. Flight ticket office is at right.

TRAPPED BRITISH BURMA UNITS SAVED FROM SURRENDER BY

Curtiss Commando Transports

THE high tide of the Jap Burma invasion found many British ground forces surrounded by jungles and Japs. Roads blocked... bridges down... supplies exhausted, they were completely cut off.

There was one lifeline neither nature nor the Nips could cut —Combat Cargo Command pilots flying Curtiss Commando transports.

These world's largest, fastest twin-engined carriers roared in low over isolated clearings, cascaded burlap-wrapped bundles of food, medicine and ammunition to the beleaguered men below—kept them fighting when all other means failed —kept them alive to fight free of the enemy.

All over the world, all through the war, Curtiss Commandos have flown under every condition, delivered anything needed anywhere in the cause of victory.

Once that full victory is attained, watch these famed air carriers make equally creditable contributions to peacetime commerce. Their speed, dependability and economy will earn them front rank in the fields of air travel and air trade.

Printed in U.S.A.

Rugged Construction of the U. S. Navy's Grumman Hellcat Helped Bring This Pilot Back to Fight Again

Grumman

AIRCRAFT ENGINEERING CORPORATION, Bethpage, L. I., N. Y.

TAGGING THE BASES

WITH V-J DAY BEHIND US, civil operators the nation over are drafting plans and initiating first steps to expand their aircraft services. And pacing this broad postwar move, AVIATION now likewise expands its "Tagging the Bases" feature—to afford plane and parts makers, distributors, operators, and flyers a valuable business fostering news-check on the growing flight, service, and sales activities.

•

Joe Garside, of Wiggins Airways, based at Boston, Norwood, and Westfield, Mass., announces new charter system on per-mile basis instead of by the hour. Short stopovers at destinations are allowed, and return trips are priced on same rate as one way.

Southeastern Air Service, Atlanta, Ga., recently suffered a bad fire but resumed flight instruction within a few hours, using a Piper and Taylorcraft which were pushed out of the hangar when the blaze started. However, eight company and seven private planes were lost. Total damage was about $90,000, largely covered by insurance.

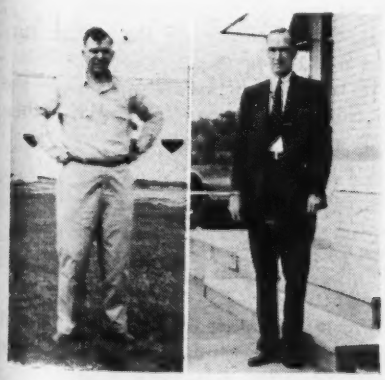
Marcel Maurier is building a mile-square airport at St. Jerome, near Montreal, Canada.

A. E. Cadle and George Lucas have opened Bamberg Flying Service at airport 3 mi. east of Bamberg, S. C.

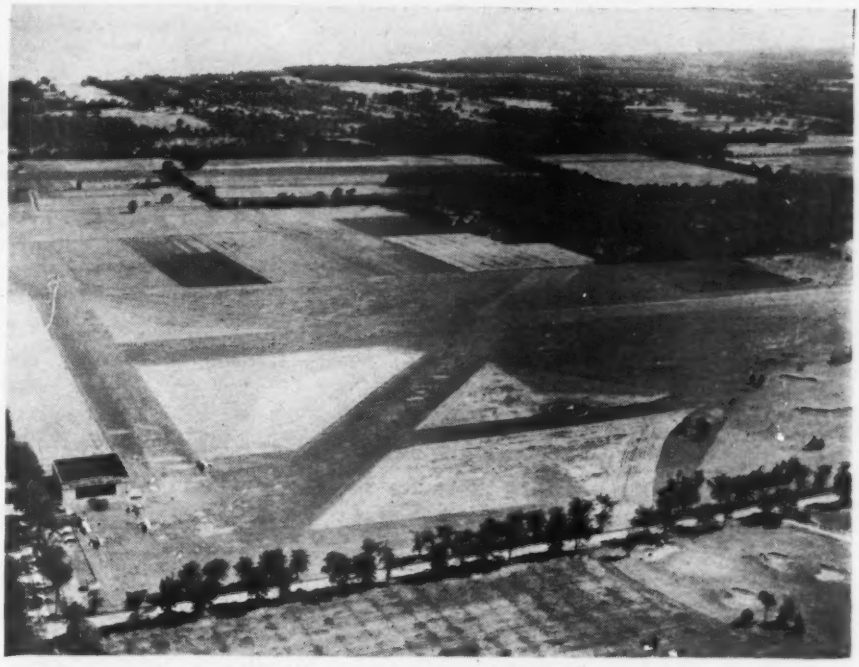
Capt. C. B. Dickinson, Owego, N. Y., has commenced scheduled flights between Tri-Cities Airport, Binghamton, N. Y., and Flushing Airport, N. Y. C. Flying time is 74 min. and fare is $15.

At Ocean City, Md., O. L. Bonifay has started work on a 150-acre airfield, base for his airline to Baltimore. Bonifay has purchased a Boeing 247 from CPA and is negotiating for flying boats. Ocean City-Baltimore fare is $10 but may be reduced if volume of traffic permits.

At Beechurst, Long Island, N. Y., James N. Callinicos has opened Queens Seaplane Base on a sandy bay. Included is a clubhouse in the $75,000 class. Float and ramp have already been constructed.



Two more "basers" who are getting lengthened runways. Both Connecticut field managers, they're Ernie Markham (left) of Meriden Municipal Airport, who reports additional 60 acres are being purchased, and Jack Tweed (right) of New Haven Municipal Airport, where runways are being extended to 4,000 ft. Latter has managed N. H. port for past 18 yr.



Lost Nation Airport, Willoughby, Ohio, operated by F. C. Sulzer for Dethloff Flying Service. Land has been purchased to allow extension of major runways to 6,000 ft.

Not content with being credited as first to loop a Ford Trimotor, Clyde Ice, at Spearfish, S. D., early this year shot 320 coyotes from air in two-month period. (Black Hills Studio photo)

Washington Aviation Country Club, at the nation's capital, is remodeling the old Beverly Hills Golf Club course and clubhouse to provide landing, hangar, and club facilities for members.

At San Fernando, Calif., Marvin Whiteman is building an air-park of which 64 acres are graded. Runway is 3,200 ft. and tie-downs for 200 planes are being provided. Further, office and waiting room are completed and two $30,000 hangars are being built.

Following airports are now designated as official ports of entry for private planes flying from Canada: Havre, Mont.; Hinde Airport, Sandusky, Ohio; and Watertown, N. Y.

Easton, Md., airport, with 4,000-ft. hard surfaced runway, has been leased by Cities Service Co. of Pa.

At Mansfield, Ohio, Municipal Airport, J. R. Harrington is opening a $60,000 restaurant and service building.

Otto Aviation, Bloomfield, N. J., has accepted delivery of two Lockheed Lodestars for use on company's Teterboro-Atlantic City run. Craft replaces the smaller planes now in use.

Cornelia Fort, at Nashville, Tenn., is now listed as combination airport and air-harbor by CAA designation.

W. E. Mellor, of Mellor-Howard Seaplane Base, Ridgefield Park, N. J., has returned from the Army.

San Mateo Airport, in California, has been opened for training and practice flying, following certification by CAA.

Wiley Post, of Lehigh Aircraft, Allentown, Pa., Airport, reports orders for 125 Taylorcraft.

Embry-Riddle of Chapman Field, Miami, Fla. and Southern Airways Sales Co. of Birmingham, Ala., have been appointed surplus sales centers by RFC.

Airport at West Haven, Conn., has been leased by Bob Hall, of West Haven Air Service.

Charles K. Grieder, of Martin's Creek Airport, Pa., has contracted to give flight instruction to women students of Centenary Junior College, Hackettstown, N. J. He will be assisted by two former Wasps, Margaret Bergh of Tuckahoe, N. Y., and Patricia Kenworthy of Glenside, Pa.

HOW JET PROPULSION SIMPLIFIES CRUISE CONTROL

By **JAMES B. REA**, *Engineering Test Pilot and Design Specialist, Consolidated Vultee Aircraft Corp.*

Presenting basic engineering parameters for jet propulsion, Specialist Rea compares them with those for the conventional aircraft and shows how their application to flight testing simplifies cruise control.

A JET-PROPELLED AIRCRAFT makes use of the reaction thrust provided by rapid ejection of gases from suitably shaped nozzles. Air—the working fluid—is scooped up, compressed, and passed into a combustion chamber where its temperature is increased by the burning of fuel. Expansion of this burning mixture through nozzles produces a high-velocity jet. Power sufficient to drive the compressor is taken from this jet by a turbine, and with further expansion of the gases, the resulting exit velocity is used to produce the reaction thrust.

Derivation of Thrust

The derivation of the force equation for net thrust, in terms of jet velocity, airplane velocity, weight rate of air flow, and weight rate of fuel flow, is well known in the field of engineering. It is based upon the fundamental principle that force is equal to rate of change in momentum. Expressing this principle in mathematical terms, the equation for net thrust becomes:

$$T = \left(\frac{W_a + W_f}{g}\right) V_j - \left(\frac{W_a}{g}\right) V_p$$

Static thrust is defined as net thrust when the airplane velocity, V_p, is equal to zero.

Examination of the equation for net thrust indicates that if W_a, W_f, and V_j, were held constant, net thrust would decrease linearly from the static thrust with increase in V_p. But actually, W_a, W_f, and V_j increase with increase in V_p at constant turbo-rpm. (assuming constant W_f/W_a), because of the increase in ram pressure at the compressor inlet). Thus, for constant turbo-rpm., the decrease in net thrust with increase in V_p is *not* linear. And, at exceedingly high values of V_p, the net thrust for constant turbo-rpm. may even increase with the increase in V_p, and eventually exceed the static thrust. The reason for this is obvious when it is remembered that ram pressure at compressor inlet increases as V_p^2.

Typical curves of available net thrust at constant density altitude plotted against airplane velocity for constant turbo-rpm. are shown in the accompanying illustration. (Actual ordinate and abscissa values have been omitted for security considerations.)

It should be stressed that the curves do not represent required thrust for various values of airplane velocity, but represent *available* thrust.

The second term, $(W_a/g)V_p$, in the equation for net thrust is commonly known as ram drag, and it represents the drag force resulting from continuous scooping of air as the plane moves forward.

Symbols Defined

T	= Net thrust, lb.
W_a	= Weight rate of air flow, lb./sec.
W_f	= Weight rate of fuel flow, lb./sec
W_f/W_a	= Fuel-to-air ratio.
V_j	= Jet velocity of exit gas relative to airplane, ft./sec.
V_p	= True velocity of airplane relative to air, ft./sec.
η_t	= Gas-turbine efficiency.
η_p	= Propulsive efficiency.
η_o	= Over-all efficiency.
sfc.	= Specific fuel consumption = $3{,}600\ W_f/T$
rpm.	= Revolutions per minute.
g	= Acceleration of gravity = 32.2 ft./sec./sec.
H	= Heating value of fuel, Btu./lb.
Btu.	= British thermal unit of heat content.
J	= Mechanical equivalent of heat = 778 ft.-lb./Btu.
bmep.	= Brake mean effective pressure, lb./in.^{2}.
$(W_a/g)V_p$	= Ram drag, lb.

Gas Turbine Efficiency

By definition, gas turbine efficiency is equal to the rate of useful work done on the fuel and air, divided by the mechanical equivalent of the rate of expenditure of available heat energy stored in the fuel. Thus,

$$\eta_t = \frac{\frac{W_a}{2g}\left(V_j^2 - V_p^2\right) + \left(\frac{W_f}{2g}\right)V_j^2}{W_f HJ}$$

and simplifying,

$$\eta_t = \frac{(W_a + W_f)\ V_j^2 - W_a V_p^2}{2g\ W_f HJ}$$

As defined above, the gas turbine efficiency is not the efficiency of the turbine wheel as it absorbs energy from the jet to drive the compressor; rather, it is the efficiency of the entire turbine unit.

It may be of interest to note the relationship between V_j and V_p when η_t is equal to zero.

For this case,

$$(W_a + W_f)\ V_j^2 - W_a V_p^2 = 0$$

or,

$$V_p = V_j\sqrt{1 + \frac{W_f}{W_a}}$$

For a fuel-to-air ratio, W_f/W_a, equal to .02—not uncommon for a jet engine—we have the following relationship: η_t is equal to zero when

$$V_p = V_j\sqrt{1 + .02} = 1.01\ V_j$$

Thus, when the velocity of the plane is only slightly greater than the velocity of the jet, the gas turbine efficiency is equal to zero.

This derivation also indicates that gas turbine efficiency increases with increase in jet velocity if the other factors in the equation are held constant.

Propulsive Efficiency

Propulsive efficiency is defined as the rate of work done on the airplane, divided by the rate of useful work done on the fuel and air. Thus,

$$\eta_p = \frac{TV_p}{\frac{W_a}{2g}(V_j^2 - V_p^2) + \left(\frac{W_f}{2g}\right)V_j^2}$$

By substituting the equation for net thrust, T, previously derived we have:

$$\eta_p = \frac{\left[\left(\frac{W_a + W_f}{g}\right)V_j - \left(\frac{W_a}{g}\right)V_p\right]V_p}{\left(\frac{W_a + W_f}{2g}\right)V_j^2 - \left(\frac{W_a}{2g}\right)V_p^2}$$

and simplifying, this becomes

$$\eta_p = \frac{2(W_a + W_f)V_j V_p - 2W_a V_p^2}{(W_a + W_f)V_j^2 - W_a V_p^2}$$

This equation shows that the propulsive efficiency, η_p, is equal to zero when the velocity of the plane, V_p, is equal to zero.

The equation also shows that if the effect of the weight rate of fuel flow, W_f, is neglected, the propulsive efficiency is a maximum when the velocity of the plane is equal to the velocity of the jet. But this has no practical significance because, as already shown, for $V_p = V_j$ the gas turbine efficiency is nearly equal to zero, and thus the over-all efficiency (equal to $\eta_t \times \eta_p$) would be nearly equal to zero.

Over-all Efficiency

Also by definition, the over-all efficiency is equal to the rate of work done on the plane, divided by the mechanical equivalent of the rate of expenditure of available heat energy stored in the fuel. Thus,

$$\eta_o = \frac{T\,V_p}{W_f\,H\,J}$$

By substituting the previously derived relationship for net thrust, T, this equation becomes,

$$\eta_o = \frac{V_p(V_j - V_p) + \left(\frac{W_f}{W_a}\right)V_j V_p}{\left(\frac{W_f}{W_a}\right)J\,g\,H}$$

This equation shows that the over-all efficiency, η_o, is zero when the velocity of the plane is zero. And, by equating the partial derivative of η_o, with respect to V_p, equal to zero, we have the following condition: η_o is a maximum when

$$V_p = 1/2\,V_j\left(1 + \frac{W_f}{W_a}\right)$$

Since the term W_f/W_a is comparatively small, it may be assumed with very little error that the over-all efficiency, η_o, is a maximum when the airplane velocity is equal to half the jet velocity.

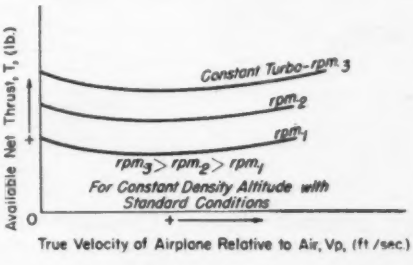
Specific Fuel Consumption

This is defined as fuel consumed in lb./hr./lb.-of-net-thrust. Thus,

$$\text{sfc.} = \frac{3{,}600\,W_f}{T}$$

Comparing Conventional Engine

Just as bhp. is the basic parameter for measuring the output of a reciprocating engine, so thrust is the basic parameter for measuring jet engine output. And just as sfc. (specific fuel consumption) for a reciprocating engine is stated in lb./hr./bhp., sfc. for a jet engine is defined in terms of lb./hr./lb.-of-thrust.



Typical curves of available net thrust at constant density altitude plotted against airplane velocity for constant turbo-rpm.

The three main efficiencies for plane propelled by a reciprocating engine are: (1) Brake thermal efficiency, (2) propeller efficiency, and (3) over-all efficiency. And, by comparison, the three corresponding efficiencies for a jet-propelled plane are: (1) Gas turbine efficiency, (2) propulsive efficiency, and (3) over-all efficiency.

For a plane with a reciprocating engine, over-all efficiency is equal to the product of brake thermal efficiency and propeller efficiency; and for the jet-propelled plane, the over-all efficiency is equal to the product of gas turbine efficiency and propulsive efficiency.

An alert pilot who operates a plane propelled by a reciprocating engine particularly notes cylinder-head and oil temperatures, and oil and fuel pressures. Particularly observed in the operation of jet plane propelled by a gas turbine, are tail pipe and bearing temperatures, and oil and fuel pressures.

Maximum bmep. and maximum engine rpm. are normal bhp.-limitations for a reciprocating engine; and correspondingly, turbo-rpm. is a normal thrust limitation for a jet engine.

Cruise Control Simplified

With a reciprocating engine, the pilot may obtain a given bhp. with many combinations of manifold pressure (or bmep.) and engine rpm. Thus, for the conventional plane, there is a flight-testing problem of determining which combination gives the best range for any given speed, density altitude, gross-weight, and mixture setting, and in addition, which speed, with optimum combination of manifold pressure (or bmep.) and engine rpm., will give the best range. But for a jet-propelled airplane, which uses a gas turbine, there will be only one level-flight speed for each turbo-rpm., at a given gross-weight and density altitude, with the result that the corresponding problem of flight-testing to obtain cruise-control data will be greatly simplified.

Thus, for a jet airplane, it will only be necessary to determine the speed and corresponding turbo-rpm. for best range, for any density altitude and gross-weight. To account for small changes in thrust-available, resulting from deviations in temperature from standard atmospheric values at a given density altitude, minor corrections in turbo-rpm. required for a given airplane velocity can be applied to jet propulsion cruise-control charts, just as minor corrections in required manifold pressure for a given plane velocity (constant engine rpm.), are applied to the conventional control charts to account for available power variations with change in carburetor air temperature at a given density altitude.

New designs for jet engines may use a variable tail pipe area. But if this further refinement is made to operate automatically, it should not complicate the cruise control picture.

Value of Thrust Meters

It is anticipated that, in the near future, thrust meters will be available for accurate flight testing of jet-propelled craft. These meters will allow pilots to measure and distinguish between thrust required and thrust available, and thus separate airplane drag characteristics from engine thrust characteristics. If a new plane fails to meet predicted high speeds, a thrust meter will quickly determine whether it is the fault of drag predictions or jet engine thrust guarantees. Even though cruise control has been made simple by the development of the jet-propelled plane, it will be more simple when an accurate thrust meter has been perfected.

The advent of jet propulsion has given pilots and engineers a new set of basic engineering parameters. When compared with those for conventional aircraft, these parameters are simple and easily understood, and when applied to flight testing or cruise control their comparative simplicity is even more pronounced.

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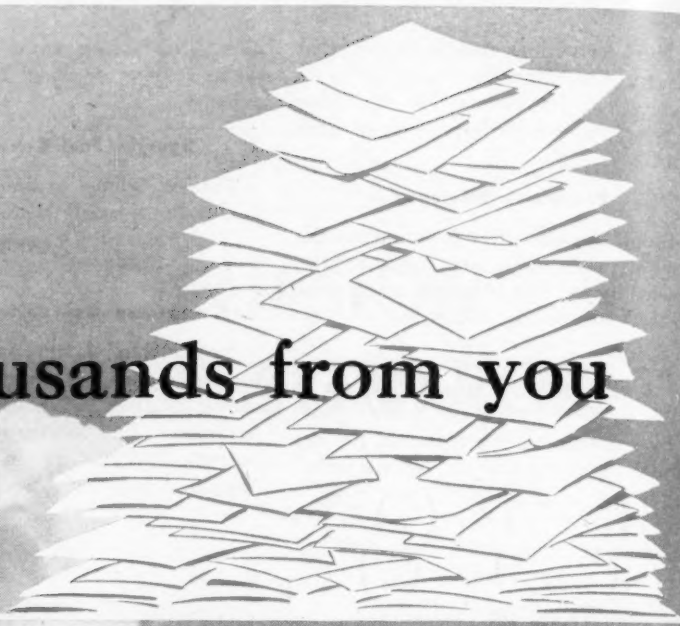

asking about the new postwar line of Cessnas

Ever since we interrupted our program of manufacturing private airplanes to turn out military aircraft, during these war years, we have received thousands of letters asking, "What are the new postwar Cessnas going to be like?"

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From thousands of letters and interviews during the past four years we believe that we know now what features you want most and can use best in the airplane you buy.

Here they are:—

1. Safety 2. Speed 3. Performance 4. Comfort
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As a result we have deliberately combined all of these features into a completely new line of high-wing, metal airplanes, equipped with a new, patented landing gear, in a wide range of speeds and prices.

Prewar, we built the famous Cessna Airmaster, three times judged the world's most efficient airplane in open, international competition.

Postwar, we intend to give you even greater speed and performance plus an all-time high in safety, comfort and economy.

You'll notice that our signature reads "Cessna, the Pilot's Airplane." We say that advisedly because we believe that a pilot's airplane is safe, fast, easy-to-fly . . . and not a "hot," hard-to-fly airplane.

If you are a pilot now you want a pilot's airplane as all statements from pilots indicate. If you are not a pilot now, you will be when you start flying. Then, you, too, will want a pilot's airplane. So why not point your thinking in that direction now.

Since we built the last Airmaster we have gained a wealth of knowledge and experience in precision manufacturing and engineering on our war program.

Tomorrow, in one of the most modern, efficient and wholly-owned aircraft plants in the world, we will add that new precision experience to our 34-year background in aviation to produce the airplane that we sincerely believe you want most and can use best.

★ ★ ★

This is the first of a series of messages that will give you complete information about the new, postwar line of Cessnas.

Cessna

THE PILOT'S AIRPLANE

Banks Opening Books To Personal Plane Financing

Seeing a favorable future for local air developments, bankmen prepare not only to handle paper on new and used craft but also to finance dealer displays and likewise grant credit for flight course, airpark, and feederline activities. Here, Mr. Hoadley ranges the path of this move, meanwhile revealing the A.B.A.'s role in supporting it.

By RAYMOND L. HOADLEY, *Financial Editor, "Aviation"*

WHEN CIVILIAN PLANES start rolling off assembly lines again this fall and winter, the banks will be ready with the necessary credit to finance sales.

Retail financing of airplanes to private operators had been a totally alien endeavor to most banks in the past. Only a few such institutions scattered over the nation financed plane sales before the war. But even the most conservative of bankers knows now that the era of transportation in the air is really here and that it will have much the same sort of impact upon our financial economy as the steamship, railroad, and automobile transportation eras.

Bankers realize that although air transportation is on a national scale, still there are many future opportunities for local financial development. Not only will the bankers compete with commercial finance companies for the financing of new and used planes but they also will arrange for floor planning of aircraft dealers, and likewise finance flight courses, airparks, area and feederlines, and even rural ventures providing passenger and cargo service between towns and offering connections with trunkline air services.

Bankers all over the country have been seeking information on the mechanics of financing private plane sales. It is notable here that officials of the American Bankers Assn. are offering a guiding voice—and the Association speaks so authoritatively that both dealers and prospective plane owners can get an idea of just what to expect from their local bankers when they want credit.

The A.B.A. feels that the fundamentals of financing airplanes are not greatly different from those long established in the automotive business. Retail credits will have to be considered carefully because of the size of the transaction, according to Carl M. Flora, Milwaukee banker and chairman of the Association's Consumer Credit Committee. Wholesale financing for the dealer, he believes, will have to be based on the dealer's integrity and sales ability, as well as on products handled and financial worth.

The major difference in financing air craft, in contrast to other kinds of merchandise, arises from the higher physical risks to which aircraft are exposed and the relatively high cost of upkeep. It has been estimated that aircraft owners shoulder an average annual maintenance cost (including repairs and insurance) which approximates 40% of the plane's original cost.

The big difference between aircraft and automobile financing is that registration and operation of planes are federally controlled, while the various states control motor car registration, etc. The Consumer Credit Committee of the A.B.A. has published a handbook spelling out the government regulations and controls governing the ownership and operation of aircraft, also reproducing the forms that have to be used. Furthermore, the booklet contains illustrations of the basic forms which bankers should use in aircraft financing.

With respect to insurance, the committee advises that banks make arrangements with an aviation insurance underwriter on all aircraft financing transactions. Many of these insurance companies maintain engineering services at various points throughout the country, including a record of current aircraft values determined from original list prices.

As a guide, the A.B.A. advises that the minimum insurance requirements on lightplanes should be a participating all-risk crash-including policy under which the maximum participation of the insured does not exceed 33⅓%. The percentage of participation would depend upon the use to which the plane would be put, as well as qualifications of the pilot. Insurance rates range from $11.50 to $15 per $100 of appraised value. On

(*Turn to page 239*)

Better Control . . . .

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VICKERS AIRCRAFT POWER BRAKE VALVES

These valves have true "hydraulic feel" . . . the resistance to brake pedal movement is hydraulic and directly proportioned to the pressure in the brake. In the event of pressure or brake failure, the pedal is depressed without appreciable force thus giving the pilot instant warning of pressure loss. The time interval between pedal movement and brake application (or release) is minimized thus giving the immediate brake action which eliminates the tendency to overbrake.

These valves have high efficiency and are uniform; the control obtained is smooth and constant. The valve input pressure may be as high as 1500 psi and control is obtained with pressure as low as 25 psi at the brake. Accurate control of braking is independent of pressure in main hydraulic system providing only that system pressure is equal to or greater than the pressure needed to provide maximum braking force.

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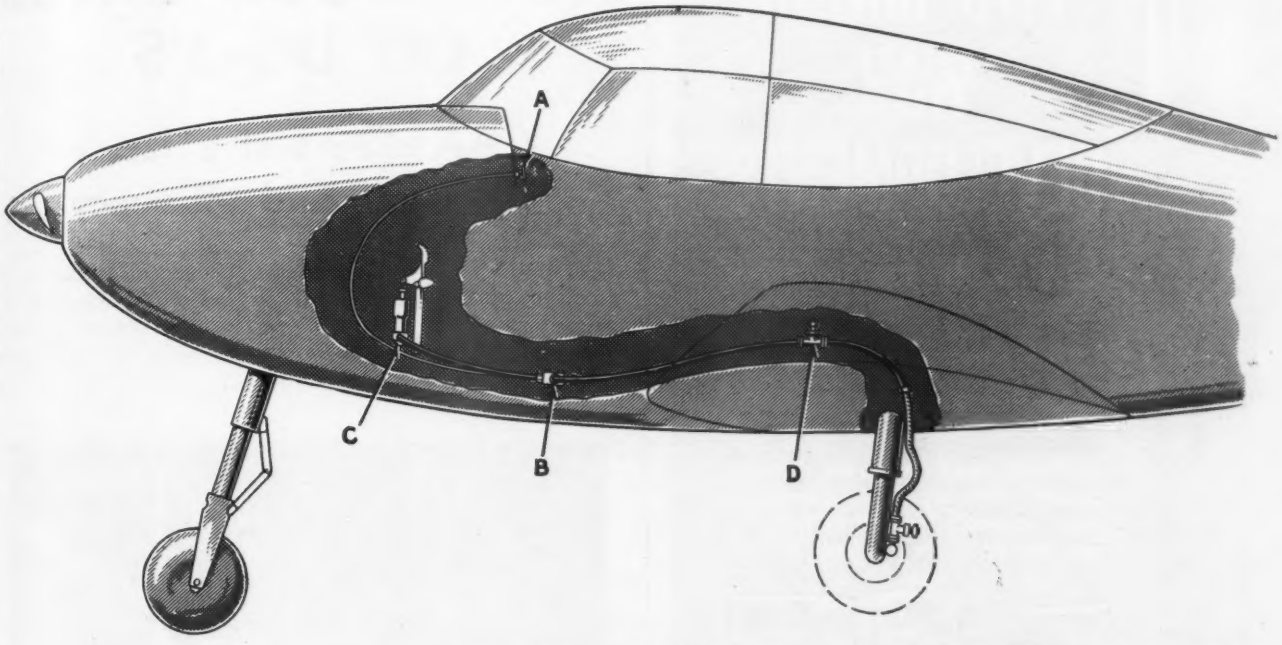
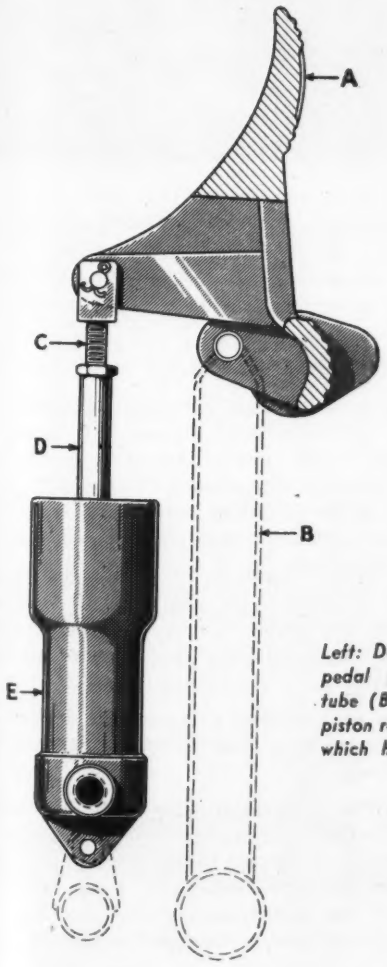
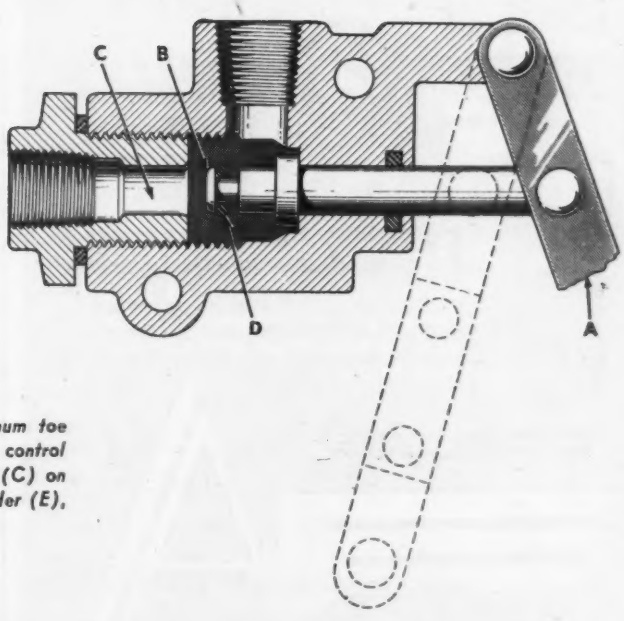


Cutaway sketch showing typical installation of Scott Aviation Corp. personal plane hydraulic brake system. Parking brake push-pull control (A) is connected by flexible cable to locking valve (B). Brakes are actuated by hydraulic cylinder unit (C), which can be built into manufacturer's own rudder control system. Bleed valve (D) is used only where system has high spot such as that shown.



Left: Detail sketch of cast aluminum toe pedal (A) attached to rudder control tube (B). Note adjustable clevis (C) on piston rod (D) above master cylinder (E), which has integral reservoir.



This cutaway sketch depicts details of Scott parking brake valve. Movement of control arm (A)—after brakes have been applied—to position shown by dotted lines, pushes piston (B) into nut (C) with "O" ring (D) sealing in the hydraulic pressure.

TWO MAJOR WAR DEVELOPMENTS

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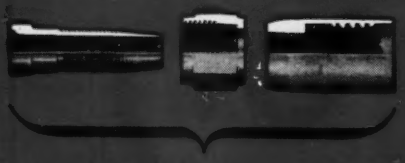
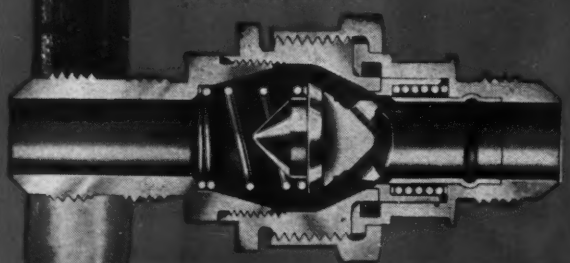


3 PIECES (each replaceable)

Assembly without special tools. No tightening or adjustment after assembly. Fittings can be removed from hose and reused over 100 times.



2. Aeroquip Self Sealing Couplings* allow disconnection of liquid carrying lines without loss of fluid and reconnection without inclusion of air.

*STANDARD EQUIPMENT ON U. S. ARMY AND NAVY COMBAT AIRCRAFT

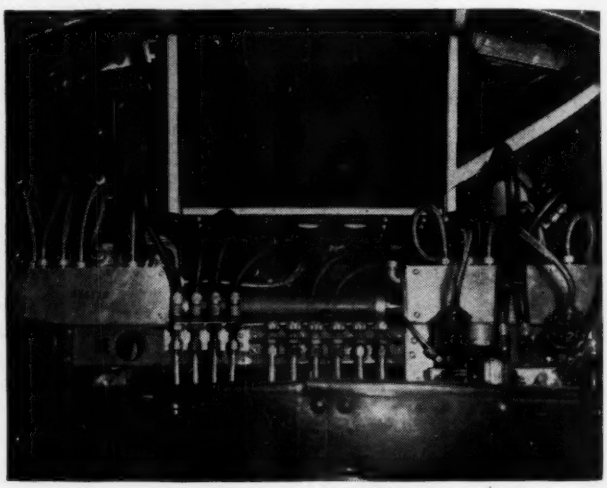
AEROQUIP CORPORATION

JACKSON, MICHIGAN, U. S. A.

NORTHWEST AIRLINES ADOPT NEW HOSE LINES ON DC-3'S

CAA Approval a factor for safety and efficiency

Coincident with Northwest's announcement of transcontinental service from Seattle to New York, linking these areas with direct one-carrier service, Northwest Airlines engineers have reported on favorable tests of Aeroquip hose assemblies with detachable fittings.



"The ease of maintenance of these hose assemblies in connection with our new plumbing has prompted us to authorize the same installations on our entire fleet," stated an NWA official in describing the new DC-3 instrument system.

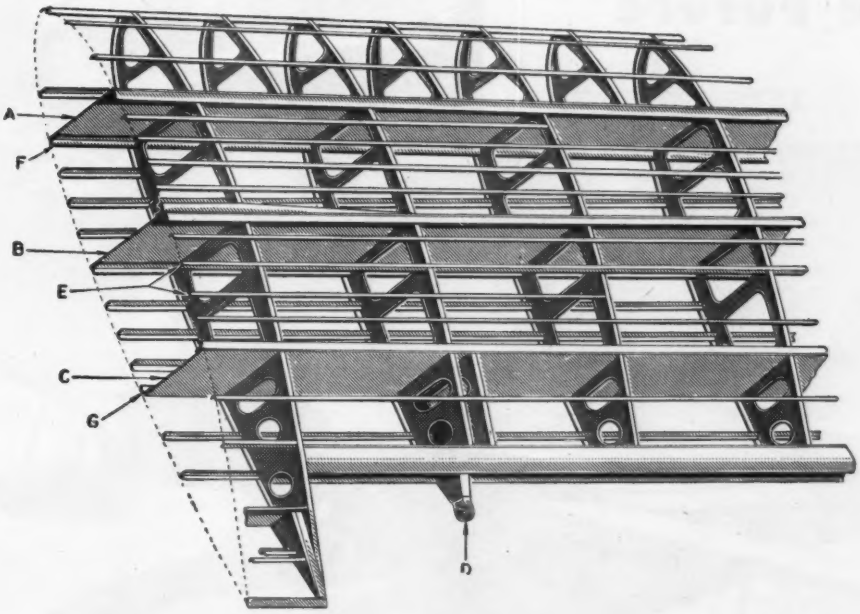
CAA APPROVAL

A factor supporting the high performance record of Aeroquip hose lines and detachable fittings, and Aeroquip Self-Sealing Couplings, is the approval currently granted by the CAA for civil aviation applications. These lines and couplings, meeting A-N specifications, are in use on American military and naval aircraft throughout the world.

The CAA approval, set forth in Product and Process Specification P & P 3-6, covers the eligibility of Aeroquip hose assemblies with detachable fittings and self-sealing couplings for specified hydraulic, fuel, oil, vacuum and instrument line applications.

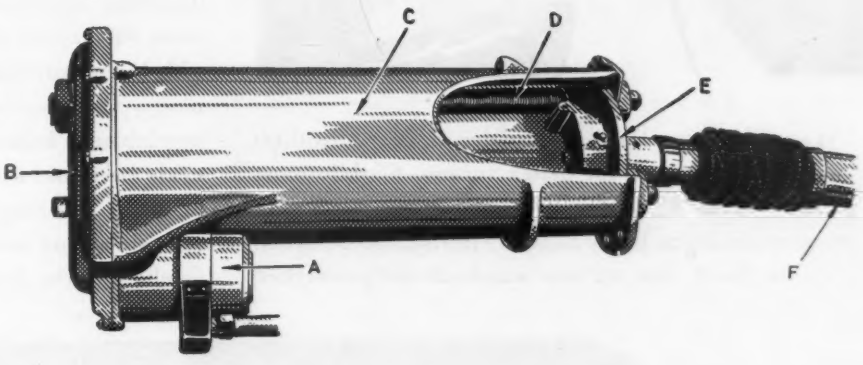
Fire resistance is an approved characteristic for which Aeroquip assemblies have long been noted by engineering and operating personnel.

With over 5 million hose assemblies with detachable fittings, and nearly 1 million self-sealing couplings used, the revolutionary advantages introduced by the Aeroquip design have created an entirely new concept in hose line and coupling installations and performance, both in efficiency and in weight-saving, stock and replacement simplicity, and in safety.

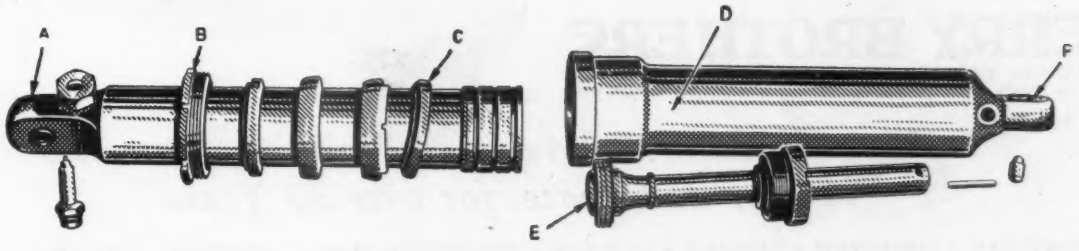


Structural view of Jap Oscar wing from above and aft of trailing edge, with front, center, and rear spars at (A), (B), and (C), respectively, and aileron hinge fitting at (D). Also shown are varying types of stringers and angular sections, those at (E) being straight-edge angle type, and those at (F) and (G) being arc type angles.

Right: Cutaway sketch of tail wheel retracting unit of Jap Betty. Gear is actuated by electric motor (A) through gear train (B) into main housing (C) to turn worm screw (D) which, in turn, moves piston (E) which retracts wheel through support (F).



Below: Exploded view of tail wheel strut of Betty medium bomber. Strut attaches to tail wheel at (A), while (B) is lock nut and (C) is typical wheel ring. Main casing is shown at (D), and metering valve (removed) is at (E). Strut attaches to plane at fitting (F).



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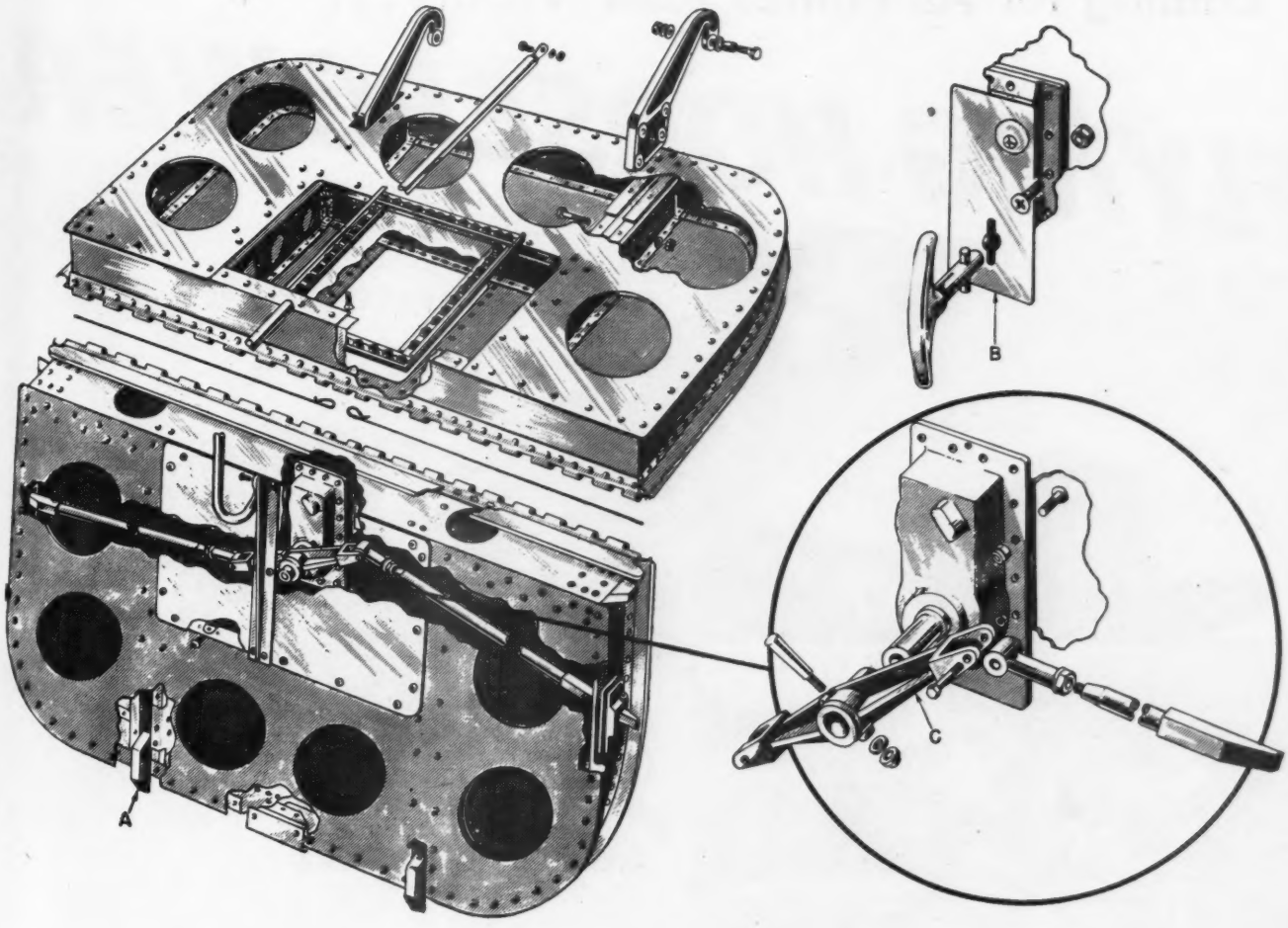
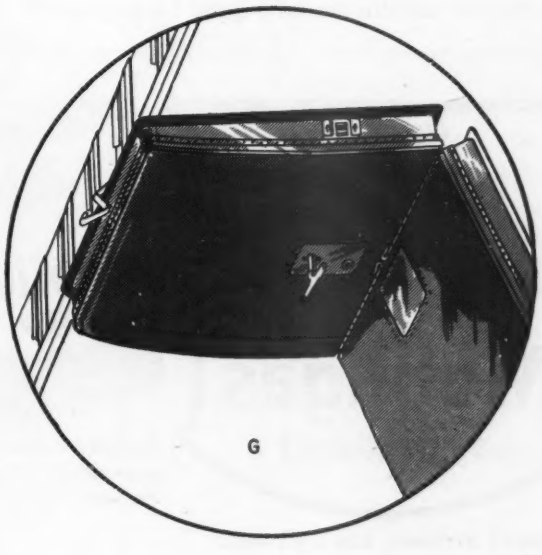
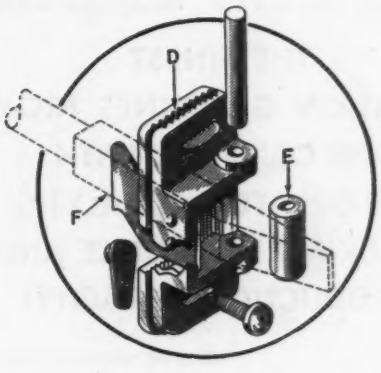


Revealed here in cutaway is Douglas C-54 forward belly cargo door, showing stops to withstand cabin pressure (A). Door lock is shown at (B), with opposite side (in circle) revealing door locking wedge mechanism (C). Below right: Detail sketch shows serrated adjustable latch plates (D), which include roller (E) for ease of entrance of latch rod wedge and anti-rattle spring (F). Below left: Circled sketch (G) shows door latched against ceiling for loading or unloading cargo and baggage.





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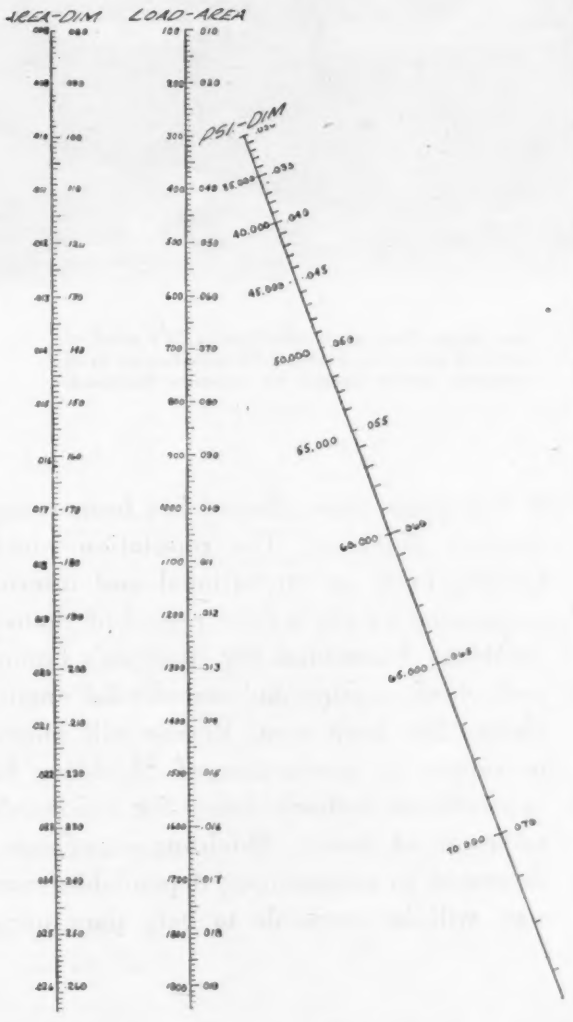
SHEET NUMBER	D-32
CLASSIFICATION	Materials
SUB CLASSIFICATION	Checking Test Bars

Nomograph for Checking Aluminum Alloy Test Bars

SAVING OF 95% OF THE COMPUTATION time formerly required in checking aluminum alloy test bars is reported by Ryan Aeronautical through employment of the accompanying nomograph. It was devised by company engineers for use when testing samples from post-aging ovens.

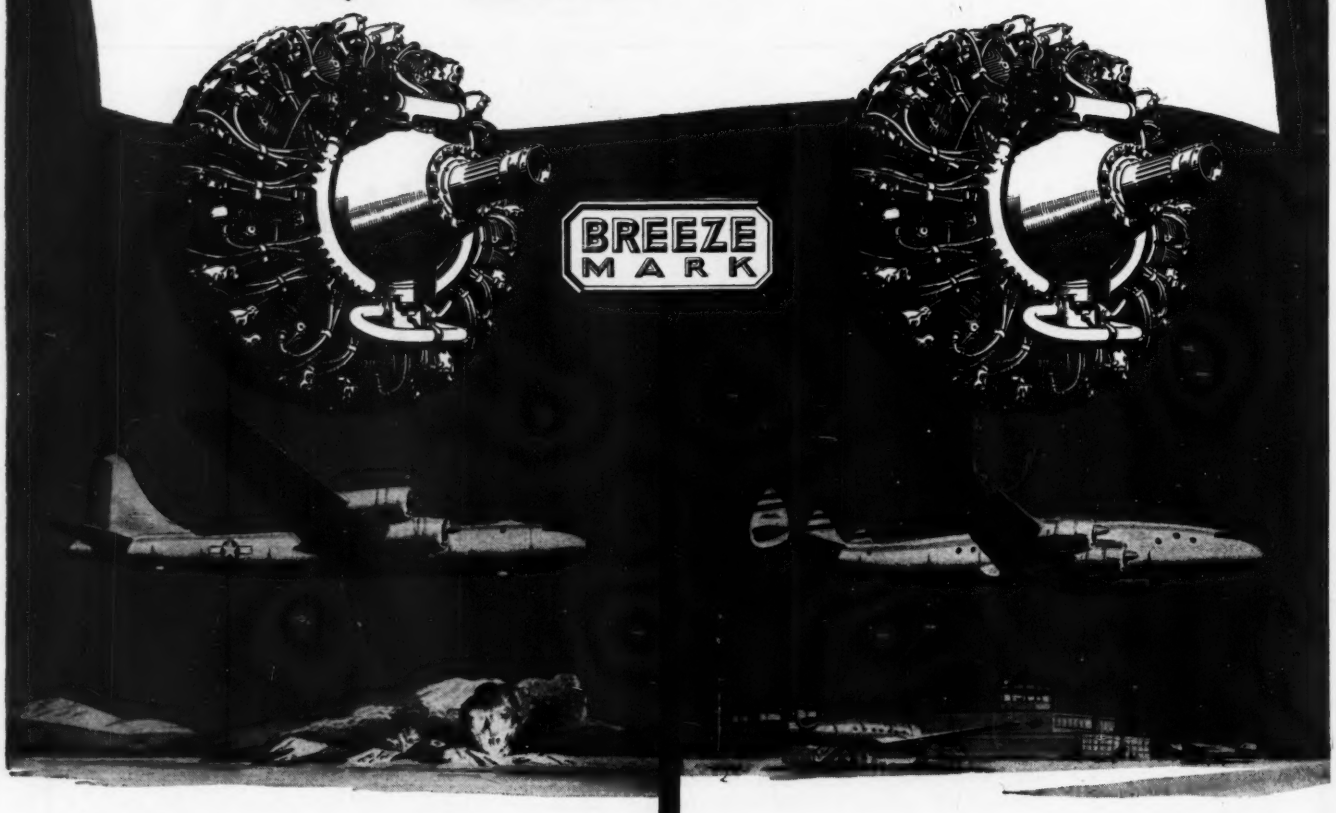
Steps required are: (1) Determine cross sectional area of bar by locating width and thickness on two dimensional scales. Laying straightedge between these points, read area from its intersection with middle scale marked "area". (2) Now locate area on left hand "area" scale, and locate ultimate load (obtained by test machine) on "load" scale. (3) Connect the above points by straightedge and extend to "psi." scale to obtain tensile strength of sample, which can then be compared with standard specifications to determine suitability of sample.

Though designed for use with aluminum alloy bars, this nomograph may be extended for use with steel or other materials.



MILITARY or COMMERCIAL

—they're BOTH Breeze Shielded



Four Breeze-Shielded Wright Cyclone 18's rated at 2200 HP power the Boeing B-29 Superfortress in its smashing attacks against the Japanese homeland.

The 55-passenger Lockheed Constellation, whose trans-continental record of 6 hours, 58 minutes was powered by four Breeze-Shielded Wright Cyclone 18's.

● For many years Breeze has been recognized as the General Headquarters for Radio Ignition Shielding. The reputation which the products bearing the Breeze Mark of Quality built up on national and international airlines before the war has now been augmented by the service record of thousands of Breeze Shielding Assemblies for America's famous fighting aircraft, tank, marine and commercial engines. When final victory has been won, Breeze will once again be able to return to production of Shielding for commercial applications without delay for reconversion. And the reservoir of Breeze Shielding experience so materially increased in maintaining dependable communication in war, will be available to help pace progress in peace.

BREEZE

Corporations Inc.

NEWARK 7 NEW JERSEY

Other Breeze Products ● SHIELDING FOR AIRCRAFT ● MARINE ● ELECTRONIC APPLICATIONS OF ALL TYPES

By A. HARRY CROWELL
Registered Patent Lawyer

FOLLOWING are digests of some of the more interesting recent patents on aviation developments granted by the U. S. Patent Office. Mr. Crowell will gladly furnish readers with free information on approximate cost and procedure in applying for patents and trademark registration. Address inquiries to him, care AVIATION, 330 W. 42nd St., New York City (18). Printed copies of any patents listed are obtainable at a cost of 10c. each, directly from U. S. Patent Office, Washington.

New Supercharger Control is effected primarily by nozzle box pressure, but is modified automatically to maintain substantially constant engine power output up to rated supercharger altitude, after which it maintains rated supercharger output, the engine power output decreasing.—2,378,441, filed Feb. 21, '42, pat. June 19, '45, A. G. Silvester, assignor to General Electric Co.

Method of Fabricating aircraft frames is intended to avoid loss of time and obviate hammering for forcing frame into shape by causing it to be bent or twisted manually to conform to desired template or jig, frame being clamped between blocks to prevent cracking or breaking at vulnerable points.—2,378,759, filed Mar. 2, '43, pat. June 19, '45, A. Fener, assignor to C. Fener.

Mechanism for Pitch Control permits automatic or manual control over a wide range, extending in one direction in positive pitch range for full feathering, and in other direction in negative pitch range for propeller braking. Mechanism is intended to operate to change pitch sufficiently fast for attaining feathering and braking positions in 1 or 2 sec. and still operate sufficiently slowly and accurately to accomplish micro-adjustments to maintain preselected speed within 1 or 2 rpm., as particularly required in multi-engine craft.—2,378,938, filed Nov. 18, '42, pat. June 26, '45, H. M. McCoy.

Tail Gear Design provides wheel held in fore-and-aft alignment during takeoff and landing and steerable for taxiing. Wheel is automatically locking but can be manually unlocked or locked and usual means are also provided for allowing wheel to swivel freely when side loads act which normally would break a locked wheel.—2,379,173, filed July 1, '40, pat. June 26, '45, C. H. Miller, assignor to Republic Aviation Corp.

Lateral Control device for use with extensible flap provides mechanical means whereby pilot, using normal control motions, may create turbulence of air in regions of extended flap, to impede lift to desired degree, thus effecting greater degree and range of lateral control. Device is described as particularly advantageous when used with extensible airfoil of Fowler type, to obtain adequate lateral control at extremely low airspeeds.—2,379,274, filed Aug. 26, '40, pat. June 26, '45, M. C. Boyd, assignor to the Ryan Aeronautical Co.

Rate of Climb Indicator designed to enable simple construction and to be extremely sensitive to changes in elevation, comprises pair of resistive elements having high temperature coefficient; fixed-volume container for mounting one element and collapsible container for other element; bleeder member, extending through container partition, having orifice opposed to resistive elements; and electrical indicating means connected to resistive elements to denote differences between impedance values due to differences

(*Turn to page 252*)

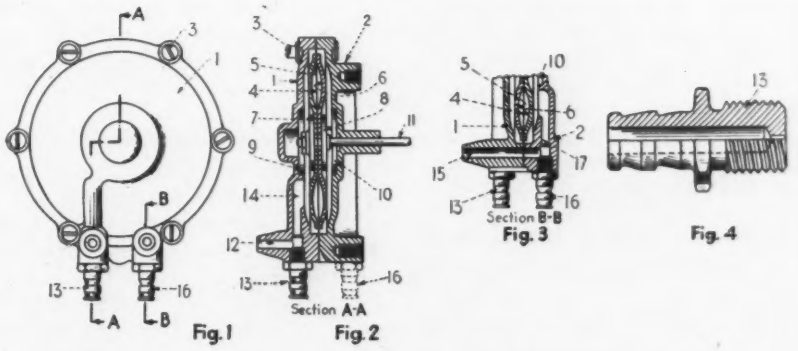


Fig. 1 Fig. 2 Fig. 3 Fig. 4

Air Relay for Automatic Pilot, features leakproof housing formed of two complementary parts in single die casting operation, yet still provides necessary inlet and outlet ports in housing's two chambers separated by conventional two-way pressure-responsive diaphragm. In accompanying illustration, Fig. 1 is end view of housing, Fig. 2 is section along A-A, Fig. 3 section along B-B through air outlet passage and nozzle, and Fig. 4 is enlarged section of outlet nozzle. Castings (1) and (2) are joined by series of screws (3) also passing through two-way pressure-responsive flexible diaphragm (4) held by stiffening plates (5) and (6) and retaining members (7) and (8). Plates (5) and (6) have smaller dia. than diaphragm, stiffen latter against sagging, but permit sufficient flexing for operation. Diaphragm divides space between concave faces of complementary castings into separate chambers (9) and (10) in which differential pressure operates diaphragm away from central neutral position. Connected to diaphragm is shaft (11) to operate conventional balanced oil valve.

Casting (1) includes air outlet passage (12) and other passage threaded to receive removable inlet nozzle (13), both being in communication with channel (14) leading to chamber (9) on left side of diaphragm. Casting (2) includes air outlet (15) and other passage threaded to receive removable inlet nozzle (16), both being in communication with channel (17) leading to chamber (10). When air in latter is exhausted under control of restricted inlet nozzle (16) and through passage (15), diaphragm is drawn to right, forcing shaft to right to operate balanced oil valve. Similarly, when chamber (9) is exhausted under control of restricted inlet nozzle (13) and through passage (12), diaphragm is drawn to left, forcing shaft to left, operating oil valve accordingly.—2,379,299, filed Oct. 14, '42, pat. June 26, '45, R. M. Heintz, assignor to Jack & Heintz, Inc.

Recent Books

HOW TO SPEED UP SETTLEMENT OF YOUR TERMINATED WAR CONTRACT, by J. K. Lasser. McGraw-Hill Book Co., Inc., New York City. 186 pages, text, graphs, index. $3.50.

Designed for the guidance of small and large plants when war orders are cancelled or curtailed. Includes information, for subcontractors, on procedures for maximum protection.

PLASTICS IN PRACTICE, by John Sasso and Michael A. Brown, Jr. McGraw-Hill Book Co., Inc., New York City. 185 pages, text, photos, index. $4.

Review of plastics in all their successful commercial applications, providing a key to the essential facts on the "why" and "how" of plastic use. Written for those concerned with product development, design, and merchandising. Comprehensive treatment is accorded to use of plastics in aviation.

A BIBLIOGRAPHY OF VISUAL LITERATURE—1939-1944, compiled by John F. Fulton, Phebe M. Hoff, and Henrietta T. Perkins. Committee on Aviation Medicine, Division of Medical Sciences, National Research Council, Washington, D. C. 117 pages.

Compilation of indicia of medical literature in books and periodicals, relating to vision, appearing in the period 1939 to 1944, inclusive.

THERMODYNAMIC PROPERTIES OF AIR, by Joseph H. Keenan and Joseph Kaye. John Wiley and Sons, Inc., New York City. 73 pages, $2.25.

Comprising 13 modern working tables for ready computation of thermodynamic processes for air and other gases, heating air in regenerators, expansion from high temperatures, and combustion. Values are given for viscosity, thermal conductivity, Prandtl number, etc. Includes problems, bibliography.

WORKBOOK IN ELEMENTARY METEOROLOGY, by Frederick L. Caudle, M.S. McGraw-Hill Book Co., Inc., New York City. 189 pages, text, charts, glossary. $1.24.

Combines, in one volume, text materials and exercises in weather study. Emphasis is placed on application to aviation.

METEOROLOGY FOR PILOTS, by Robert W. Mudge. McGraw-Hill Book Co., Inc., New York City. 259 pages, text, charts, index. $3.

Written for pilots, emphasising simplified exposition of meteorological theory and applications to flight operations. The book explains why weather phenomena occur, giving specific suggestions for flying in various kinds of weather, and discusess the interpretation and use of weather information for flight planning.

PRACTICAL SUPERVISION, by Palmer J. Kalsemm. McGraw-Hill Book Co., Inc., New York City. 186 pages, text, drawings. $2.

A guide for the industrial supervisor on leadership for obtaining best results in satisfying both employee and management requirements.

THE SUPERFORTRESS IS BORN, by Thomas Collison. Duell, Sloan and Pearce, Inc., New York City. 218 pages, text, photos, index. $3.

The story of the development of the Boeing B-29, most competently and interestingly told. Chapter entitled "Conception"

(*Turn to page 252*)

SIDE SLIPS

ATOMISERIES

War kept us eds fit to be tied;
For censors always specified,
"You can't print that, it's classified
—To save the war!", they loudly cried.

We dreamt of Vict'ry curing that.
Oh yeah, brother?—In your hat!

Ah, peace! Our pencil once more flew
To let loose on "two-three-five U",
Freed from all that "cannot" stew.

Alas, a censor's "Stop!" anew
—"To save the peace! And we mean you!"

• Speaking of the atomic bomb—as who hasn't—maybe this one can be told now! A high government official some time ago cautioned a certain group of men—(some of whom had worked on it) against mentioning that then-verboten word. In fact, he said, don't even mention Hope Ridge, Tenn., and Hanford, Wash.

Three days later representatives of another government agency walked into his office and said, but bluntly, "Look, bub, don't even tell these guys not to talk about this thing, it's a secret project."

• Long before the story broke, we thought we understood this A-bomb very clearly. Its principle had been explained in words of one and two syllables, and we were—we thought—all ready to do our part in disseminating the essential information when the story could be broken. But that was before Hiroshima got plastered—and before the experts started giving out with the last word.

After several weeks of these subsequent atomic explanations we can only hope for one thing: That the boys who might cook up W. W. III are just as confused—and stay that way.

"Maguire's going to try and ride that nag even if Halsey doesn't."

• Kamikaze, we understand, is the Nips' word for "Divine Wind," and the Admirals tell us the planes so named were nothing but breezes. Could be, but the boys on the receiving end of the winds called them anything but a breeze. What they termed 'em is much too much for the strength of this wartime-weight paper, not to mention postal regulations.

• One of the boys who'd been much too close to the Divine Winders said Hirohito's lads had still another—one of the last planes they brought out—the name of which translated into "Mighty Wind." Said he was sure they'd named the job after some of the Nip government radio commentators.

• One of the largest aircraft manufacturers just sent us a release describing a process for making forgings from straight cylinders, in which the part can be cut from "a tube that is hollow to begin with."

Think they mean like a doughnut with a hole—to begin with?

• Another release describes a most modern multi-function instrument whose simple dials tell "as clear a story as a love letter."

Just *one* kind of love letter, chum, the kind that stands up in court.

• And, via still another release, comes the easiest and quickest reconversion job reported. Seems that in a bearing manufacturing plant the women "must pass through a narrow 'de-duster' where jets of compressed air blow the dust from their stockings and clothes.

"It's just like the amusement park 'fun-house', but the gals don't shriek; maybe because there is no gallery of guffawing males."

What the hell we waiting for men?

• Two veteran private flyers had just about decided, after long reminiscence, that they favored keeping the conventional airplane pretty much "as is." Only one thing they deplored, though—that was the lack of plumbing facilities, which got serious at times. They agreed that a bit of plumbing would certainly be grand, but disconsolately concluded that such fixtures presented an impossible design problem. Whereupon the mother of one, who had been quietly minding her own knitting, spoke up and in perfect deadpan said, "Have you boys ever thought of diapers?"

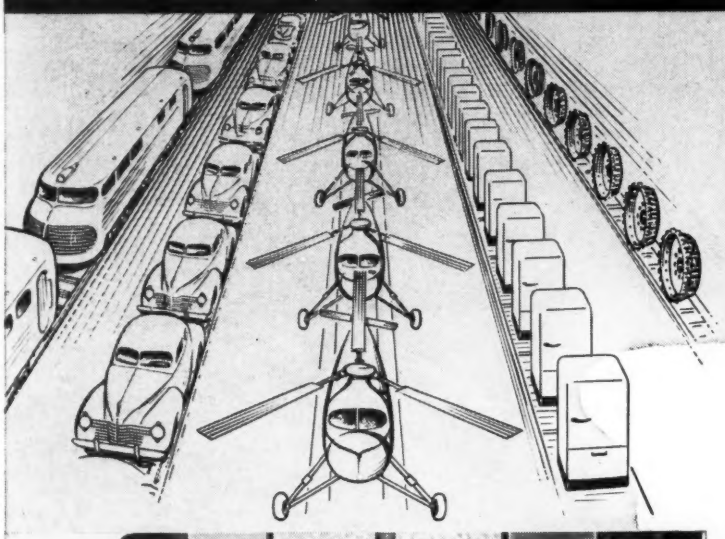
PEACETIME IN HAWAII

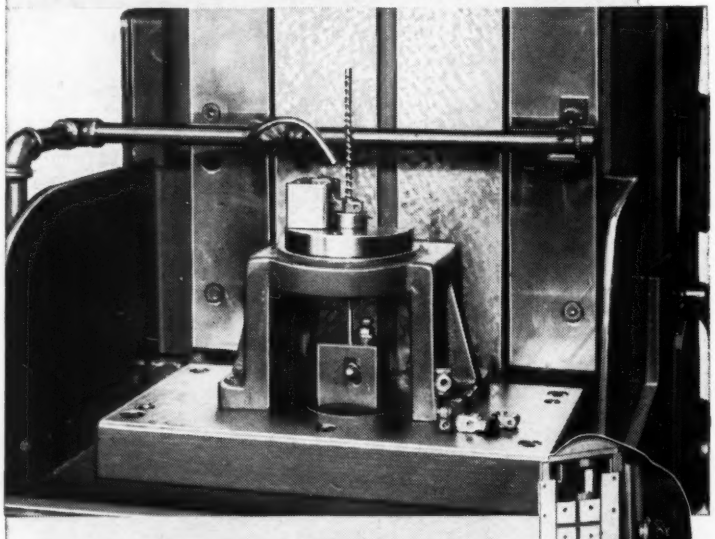
Before the bombs fell on Pearl Harbor, Bower Roller Bearings carried the rolling load in every type of automotive equipment all over the world, and will continue to do so in the postwar world, on a larger and larger scale.

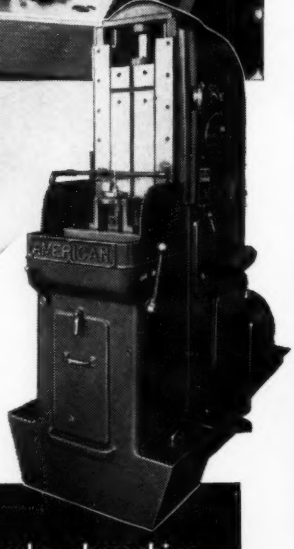
BOWER ROLLER BEARINGS

MAKE RECONVERSION EASIER

with Broaching by American







A typical set-up of the *American* T-6-24 three way broaching machine is illustrated above. For broaching small serrated holes in carburetor parts a small bridge type fixture is used. A block on top of the bridge locates the part, while the broach is held in location by a pin type broach puller. Production is fast and accurate with fine finish.

Standard equipment, capable of performing a wide variety of different tasks, can naturally eliminate many of reconversion's headaches. Standard *American* broaching machines, designed with this basic fact in mind, are made for maximum flexibility. That is why manufacturers in many industries turn to broaching by *American* to perform their metal finishing jobs.

American offers a complete broaching service—machines, tools, and engineering. *American* engineers will gladly recommend the correct standard equipment for your job, or, if necessary, design special machinery to meet your requirements. For further details, write *American* today. There is no obligation.

Avoid excess load on broaching tools. Do not attempt to broach parts that are improperly prepared.

MEMBER BROACHING TOOL INSTITUTE

American BROACH AND MACHINE CO.

ANN ARBOR, MICHIGAN

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BROACHING MACHINES
PRESSES
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DIVISION OF SUNDSTRAND MACHINE TOOL CO. ROCKFORD

THE AVIATION NEWS

BLAINE STUBBLEFIELD, Washington HERB POWELL, New York

V-J Slashes Plane Orders Nearly 90%; Research and Experimental Work Continued

. . . Boeing and Martin Programs . . . NAWP dissolving; AIA begins peacetime program . . . AAF contract schools close.

American aircraft production, the world's biggest industry, was cut back about 90% immediately after Japan's surrender, from 17 billion dollars in 1944. The shock of this near-shutdown is a major part of the Administration's problem of transition to full peace-time employment.

Best estimates available are that the industry during the coming 12 months will have a dollar output of about $1,300,000,000, plus $200-270,000,000 for civilian craft, and including production of existing designs, research, and development projects. This work will employ between 250,000 and 300,000 workers.

Habit of thinking in terms of war production caused many persons to feel dismayed over near-total curtailment. But realists in the industry pointed out that the industry will still be three or four times as big as it was in 1939, when the output of 5,865 units was valued at $279,000,000. Some aircraft industry leaders concluded months ago that a postwar mark of about a billion dollars yearly would be a practical and satisfactory goal to shoot at.

At its peak the aircraft industry had a total of 59 airplane plants, 20 engine plants, and 7 propeller plants, valued at just less than four billion dollars. The major portion of this plant space, which at a maximum totaled 175,000,000 sq. ft., belongs to the government. Some of it will be sold to the industry, some will be maintained on a standby basis, and the rest will be transferred to other government agencies for other uses.

It must be remembered that the huge aircraft industry was augmented during the war by other industries, chief among these being the auto producers, and this retraction is largely the result of converted producers going back to their original businesses. In general, "old line" trade names will constitute the industry as before the war.

On the second day after the Japs surrendered the Army cut its aircraft and allied products program, including 31,000 airplanes, by a total of $9,000,000,000 and announced that the reduction for the balance of 1945 would be about 90%, and about 94% in calendar 1946.

A tabulation of specific cutbacks on the B-29, A-26, P-47, P-51, P-80, C-54, C-82, C-47, and C-46, ranged from 58% on the P-80 to 94% on the A-26. These figures were considered temporary and subject to a complete shutdown on most at any time.

At this writing, Navy had prepared its cutback program in detail. As the Japs surrendered, Navy had $4,180,000,000 worth of aircraft on order but undelivered. Overall plan was to cut order to $1,134,000,000 as of Sept. 1. It was presumed Navy's aviation cutback would be less, proportionately, than AAF's.

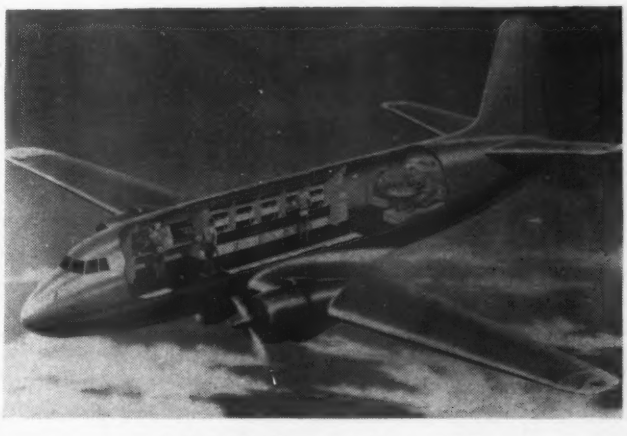
Retention of any military production at all after victory seemed to be illegal, in light of Section 202 of the War Mobilization and Reconversion Act of 1944, which seems to require a complete stoppage of war production, including research and development. OWMR director John W. Snyder has asked the Attorney General for an interpretation.

An important point is that the Army's and Navy's orders, even Schedule WX for the immediate future, and the Attorney General's opinion, are of little importance beyond the immediate months or year ahead. Sometime this year or early next, Congress will weigh the testimony of the armed forces and all interested government agencies, consider opinion from authorities everywhere on the outlook for peace or war, and then decide the strength of the Army and Navy and the relative sizes of the air arms.

Boeing and Martin Programs

Reports on two big manufacturers' immediate peace programs were available as we went to press. Boeing had orders to continue output of 155 B-29's at Seattle in August, 122 this month, and 20 per month thereafter until further change. Boeing Wichita was to continue at 100 Superfort's per month for a short time and then drop down a little. Bell in Georgia and Martin in Nebraska stopped production of B-29's at once.

Glenn L. Martin announced orders for $190,000,000 worth of aircraft products to carry it through September, 1947, operating on a 40-hr. week with no overtime. Company stated that there would be no cutbacks in its development work, and that 90% of its wartime engineering staff would be retained. Martin is negotiating with airlines and others for $44,000,000 worth of aircraft and is at work with Westinghouse on a "stratovision" craft to be used for television and FM radio transmission. Company also has contracts for metal containers in which guns, aircraft engines, and other munitions would be sealed and preserved.



TELEVISING STARS FROM THE STARS

Sketch depicts a flying relay station for transmission of television and FM radio programs, which would be utilized in a system worked out by Glenn L. Martin Co. and Westinghouse. Programs, originating in ground studios, would be beamed to craft flying at 30,000 ft., to be passed on to a fleet of similar planes which would relay programs to stations all over country. It is stated that 14 craft could cover 78% of U. S., and cost would be far below that of building enough ground stations to give same coverage. Plans call for craft with span of 161 ft. and weight of about 20 tons loaded. Two 1,450-hp. engines would give craft a 266-mph. top speed and 155 mph. cruising speed. Crew of three and six radio men would be carried. Initial flight tests of system are expected to be made this fall.

NAWP Dissolving; AIA Begins Peace-Time Program

National Aircraft War Production Councils, organized early in the war to represent the industry in its relations with the government, ceased operations the day after the Jap surrender. Richard Palmer, general manager, said that the windup would take about two months. NAWP helped to arrange important exchanges of skills, data and materials between aircraft manufacturers, and organized the industry for dealing with the Army and Navy and other war agencies.

Aircraft Industries Assn. (formerly Aero Chamber of Commerce), which was revitalized over a year ago in preparation to resume its function as the agency of peacetime aircraft makers, has its program ready and has put parts of it in effect. Eugene E. Wilson, president,

Coming Up

Sept. 2: Interhemisphere Conference on Frequency Allocations and Revisions, Rio de Janeiro. (Postponed from June 2.)

Oct. 4 - 5: IAS Light Aircraft Meeting, Detroit.

Oct. 4 and Nov. 1: SAE Southern California Section Aeronautic Meeting, Hotel Biltmore, Los Angeles.

Oct. 16: First Annual Meeting, International Air Transport Assn., Montreal.

Oct. 25: IAS Air Transport Meeting, Washington, D. C.

Oct. 31 - Nov. 3: 1945 National Aviation Clinic, Oklahoma City. (Pre-clinic conferences start Oct. 27.)

Dec. 17: IAS Wright Brothers Lecture, Washington, D. C.

complimenting industry personnel upon their wartime achievements, said that the production of commercial and personal planes is being hastened. He called upon the nation for maintenance of the industry's research and development under an air power policy that will meet our peace-keeping obligations under Article 45 of the United Nations' Charter.

AAF Contract Schools Close

Last AAF contract flying schools giving primary instruction to cadets were closed. In the five year period ending December, 1944 some 225,979 men were graduated.

Aeronautical Training Society states that AAF pilot production rate was increased from 500 to 110,000 a year in less than five years. Through utilization of civilians, most of whom were over-age for combat flying, 4-F's, and women, the AAF was able to save about 100,000 soldiers for combat. Conservative estimates indicate the monetary saving exceeded $250,000,000 yearly. By 1943 the safety factor had increased so that there was only one fatal accident for every 63,230 hr. of primary flight.

Favor Special Stall Training

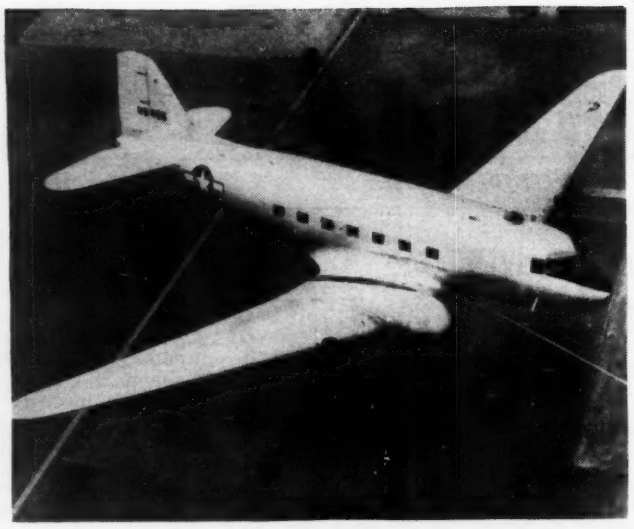
A radical change in the method of training students regarding the stalling of airplanes has been recommended to CAA by the National Research Council Committee on Selection & Training of Aircraft Pilots. The Committee concludes that, because of the frequency with which fatal accidents are associated with stalls, emphasis during training should be shifted—from precision entries into, and execution of, stalls and spins over to training in the avoidance of, and immediate recovery from, the stall condition. This might be done by extensive practice of slow flying.

The report covers 5 yr. of research in selecting and training pilots, done at some 40 universities and other institutions, under grants from CAA totaling $900,000. Controversy over whether to practice stalls or avoid them has been going on since the first world war.

New Medical Forms Out

CAA is distributing throughout the country 100,000 copies of the new pilot medical examination forms. Interested persons can obtain them from CAA's regional representatives, or direct from Commerce Building, Washington, D. C.

Apparently the forms haven't been distributed to general medical practitioners (all of whom are now authorized to give examinations), but the applicant may take the form to the physician—any physician. CAA's own designated physicians are still authorized to give the examinations, of course. Meanwhile, the National Aeronautic Ass'n is experimenting with a new medical examination form.



A LUGGER IS LUGGED

After undergoing some ingenious modifications by ATSC engineers, this Douglas C-47 was ready for use as a huge cargo glider, designated XCG-17, which can carry a payload of over seven tons and be towed at speeds of up to 290 mph. Engines and propellers of original craft were removed, streamlined caps placed over nacelles, and a tow hitch attached beneath fuselage. It is stated that craft needs no ballast and that it has a 14:1 gliding ratio.

Ask National-Park Fields

Airfields to enable flight visits to the national parks are endorsed by the Non-Scheduled Flying Advisory Committee of CAA. The recommendation goes to CAA Administrator Wright who, if he sees fit, will pass it along to the Department of Interior, which administers the parks.

The recommendation points out that motorists drive into the parks, and that pilots should be allowed similar privileges. Department of Interior would be expected to make landing areas available, presumably at government expense.

★ SPOT CHECKING ★

U. S. altitude record was unofficially broken by Lockheed Chief Pilot Joe Towle when he flew a piggyback P-38 Lightning to 44,940 ft. during a test of a new type pressure oxygen mask. Craft carried no special equipment for flight. World record is listed as 56,046 ft., a mark set by special Italian Caproni in 1938.

Story goes that a Douglas A-26 Invader recently beat out a DH Mosquito in a 1,000-mi. challenge race. Invader and Mosquito pilots met in South America and got into an argument over which craft was faster and race was slated. Seems that despite fact Mosquito took off first, A-26 arrived at finish strip 20 min. ahead of Briton.

Issued by CAA is a set of recommended standards for spacing between airports. Most controversial requirement — that airports at which instrument operations are to be conducted simultaneously would require 14-mi. separation from center to center—has been eliminated in favor of a general statement that they will require sufficient separation from center to center to prevent conflict and overlapping in holding and approach patterns during simultaneous instrument approaches.

CAA has made available over 200 fields in 41 states to communities for use as municipal airports. Communities must agree to keep them available for emergency use.

Analysis of CAA sale of surplus planes has been issued. Agency concludes that a promising potential market exists for low-priced personal planes.

New Fairchild gun synchronizer system, designated by Navy as Mark 3, works by an electrical method that permits gun placement anywhere within propeller arc. It has been successfully used to control fire of four machine guns and one cannon through one propeller. Weight and bulk of synchronizer is minimized and adjustments are stated to be reduced from hours to minutes.

Transport planes which will operate at as low as 8 mills per passenger-mile for standard version, or 4¢ per ton-mile for all-cargo versions, will be available for immediate postwar use, according to B. F. Collins, of Boeing Aircraft. Comparative figures for present equipment were given as 1.8-2½¢ and about 17¢, respectively.

A Junkers JU-290, one of Nazis' largest landplanes, was recently flown from France to Wright Field. Craft has a 138 ft. span and 92 ft. 10 in. length. Power plants develop 1,700 hp. each. With 5 tons of bombs, range is given as 2,000 mi. Top speed is put at over 240 mph. As a troop carrier, up to 90 men could be accommodated.

AA has submitted specifications to several of country's leading aircraft makers for manufacture and delivery of a new type transport. Airline wants a plane flexible enough to allow loading between range of 30 passengers and baggage, plus 500 lb. of cargo; and 20 passengers and baggage, plus 2,500 lb. of cargo. Tricycle landing gear is specified. Payload would be 6,500 lb., with enough fuel for climbing to 10,000 ft. and for cruising at that altitude against a 10 mph. headwind for 700 mi. at 275 mph.

Speedy action on naming late Col. William L. "Billy" Mitchell to posthumous rank of Major General is being requested by *The Propeller,* official publication of Air Service Veterans Assn. Journal believes action on bill now before House is being sidetracked and urges immediate action.

Convair will open a new $500,000 wind tunnel in San Diego next January. Tunnel will be located in a two-story 200x100 ft. structure, and a staff of 75 will be employed for operations.

New "baseball" type parachute has been developed for cargo-dropping by General Textile Mills. Stated features are less oscillation, ability to be launched from planes traveling at high speeds, lesser opening shock, and greater-all-round efficiency. AAF used new chute to drop mines, delicate radar sets, and portable pigeon lofts.

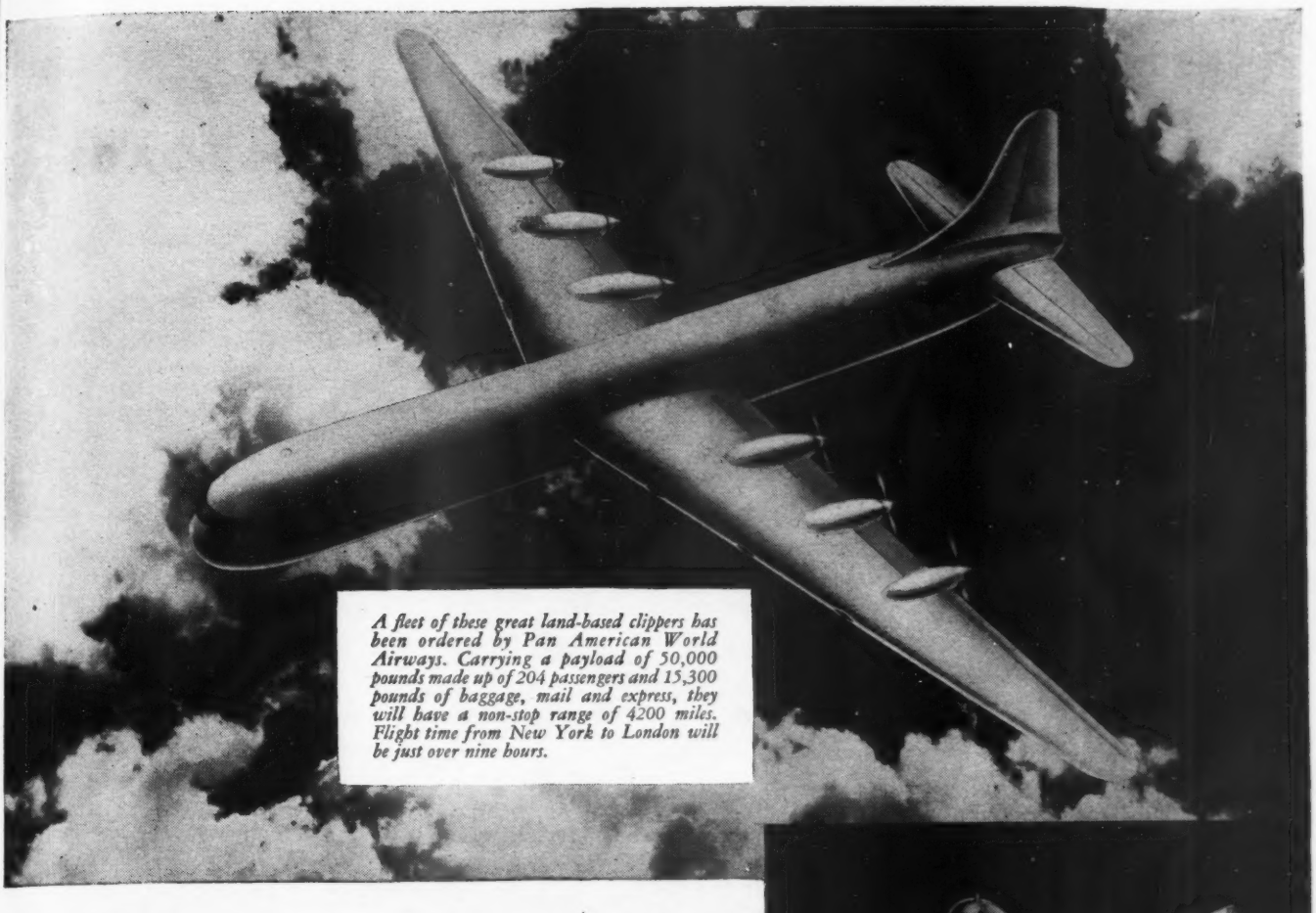
Monthly sales figures, by States, of personal aircraft sold during 1939–1941, are available from Research & Statistical Service, AIA, Washington Office.

Aetna Life Insurance Co., in air travel rider, extends accident and disability policies to cover, without additional cost, following travel: (1) Anywhere in world on passenger airliner on scheduled routes, and (2) within bounds of North American mainland as passenger in aircraft with licensed pilot, when used solely for transportation. This does not apply to double, or other extra, indemnities.

New type of supersonic wind tunnel is now being operated by NACA at Cleveland laboratories. Fundamental research on aircraft propulsion plants operating at sea level velocities up to and over 2,000 mph. is being conducted. Altitude tunnel permits investigation of operating characteristics of full-size jet, gas turbine, and conventional engines at heights of up to 50,000 ft.

Curtiss XF15C-1 fighter for Navy is stated to be a true rocket-powered craft.

Publications: *How To Do Business With RFC* is title of free booklet (available from RFC, Washington, D. C.) covering wide range of surplus items such as aircraft, industrial plants, and capital and producers' goods . . . *Airliner Maintenance* is profusely illustrated pamphlet put out by Gulf Oil. It pictures transport craft overhauls . . . Second edition of *Blue Book of Airplane Parts,* a volume for use in billing shipments, has been distributed by Traffic Service of AIA. New edition is in loose-leaf form . . . A pamphlet giving all information pertaining to applicants for mechanics' licenses is ready for general distribution by CAA . . . *War Production in 1944,* is report of chairman of WPB, Washington, D. C. Priced at 25¢, 141-page booklet gives statistics and production problems for that year . . . *Aircraft Financing,* put out by Consumer Credit Dept. of American Bankers Assn., 22 E. 40 St., N. Y. C., gives information on plane financing . . . *Surplus Property* is quarterly report by SPB to Congress. Given are statistics and data on all types of war surplus materials, with information on how that agency is disposing of them.



A fleet of these great land-based clippers has been ordered by Pan American World Airways. Carrying a payload of 50,000 pounds made up of 204 passengers and 15,300 pounds of baggage, mail and express, they will have a non-stop range of 4200 miles. Flight time from New York to London will be just over nine hours.

REVERE MAGNESIUM IN THE WORLD'S LARGEST AIRPLANE

THE great new Model 37 Trans-Ocean Transports recently announced by Consolidated Vultee are designed to carry more payload on longer flights than any other airplanes ever before proposed.

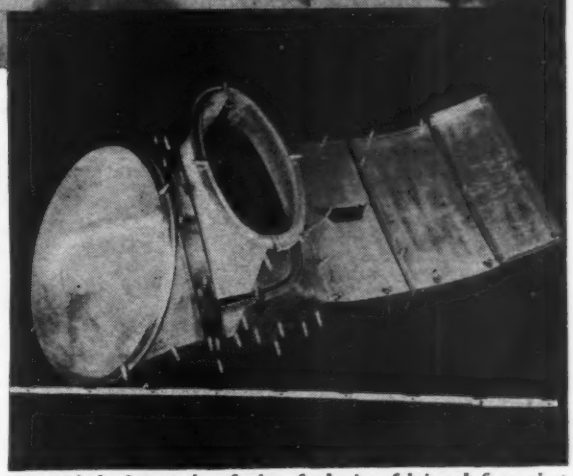
In the hangar where the first of these giants is being assembled is a sign reading: "Weigh Everything Before Placing on Plane." How seriously this principle has been followed by the engineers is shown by their extensive use of Revere magnesium throughout this airplane.

Revere magnesium alloy sheet is used in the skin, in air ducts, in the thermal anti-icing system of special design, and in a multitude of other parts. Revere magnesium extruded shapes and forgings also help to give strength with less weight to important components of this huge transport. Gasoline, oil, and other lines are made of Revere aluminum tubing.

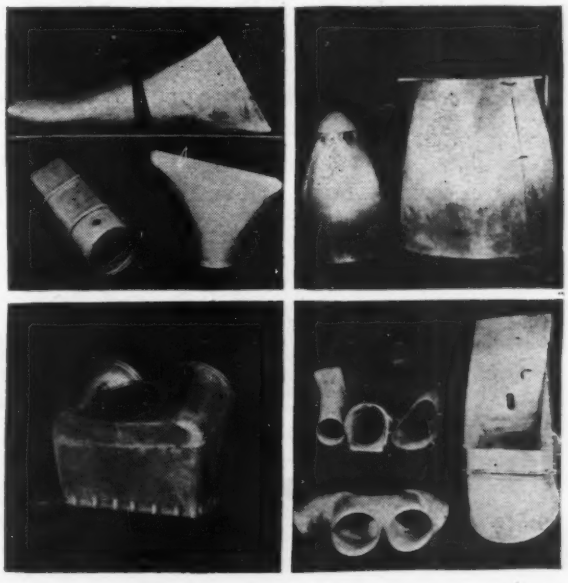
To those who have felt that fabrication of magnesium units presents unfamiliar problems, the sheet metal parts shown on this page may prove especially interesting. Revere magnesium sheet may be formed, stamped, bent, deep drawn, spun, and welded by techniques known and used by the aircraft industry and many others.

For all the facts on how magnesium can save weight in your products, call Revere. A Revere Technical Advisor will gladly give you detailed information and advice.

Listen to The Human Adventure *on the Mutual Network every Wednesday evening, 10 to 10:30 p.m., EWT*



Unretouched photographs of aircraft ducting fabricated from sheet magnesium by Magnesium Manufacturing Company, Fort Worth, Texas.



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IMAGINE your personal plane of tomorrow having—*automatically*—the extra get-up and go that today's military aircraft get from variable pitch propellers.

Actually, that's just what you can expect from the unique Aeromatic Propeller. Even under full load you'll have one-fourth shorter takeoff run, one-third higher rate of climb, greater cruising range and speed, all with minimum fuel consumption and engine wear! And you'll get long glides for happy landings—with instantaneous change of pitch for quick pickup if you overshoot the field.

This "propeller with a brain"—like no other propeller—is completely self-acting and self-contained. It automatically assumes the proper pitch for peak performance under any and all conditions of flight. You have no extra controls to fiddle with, no extra instruments to watch.

If you fly, or plan to fly, you'll want an Aeromatic Propeller on your plane. Write to your aircraft manufacturer about it today. And if you'd like our little get-acquainted folder containing a diagram of the "brain" in an Aeromatic Propeller, don't hesitate to write to: Aeromatic, 326 Scott Street, Baltimore 3, Md.

The Propeller with a Brain for Tomorrow's Plane

Aeromatic

Air Controlled *Automatic Propeller*

KOPPERS COMPANY, Inc., BARTLETT-HAYWARD DIVISION

Licensed under patents of EVEREL Propeller Corporation

FINAL COMMUNIQUE

Aviation's War Report No. 44

This 44th report on the air war, beginning with the attack on Pearl Harbor by the Japs, can record two of history's greatest events: Success of the long effort to release atomic energy in volume and under control for demolition, and the end of hostilities in the Second World War. (Also see special eight-page insert "The Atom, New Source of Energy," page 103; our editorial, "Split Elements—And Human Elements," page 105; and the feature article, "The Atomic Frame of Reference—Or Else," page 106.)

Added to these striking developments was the entrance of Russia into the war—to paralyze the Mikado's great army still remaining in Manchuria.

Fact remains that Japan surrendered without having been invaded, and most of the damage inflicted upon the former empire resulted from air attack. However, aviation had to be moved to within range of Japan by the Army and Navy which captured the island bases so necessary for air operations in Pacific.

These operations had progressed to a point where, at the war's end, the Japs would soon have been hit by forces of 1,000 B-29's, their loads of incendiaries and bombs doubled by short-haul basing, plus long range fighter and navy sweeps, totaling up to 2,000 sorties on a given day. This number was scheduled to be increased to 3,000 per day in a short time thereafter, and Gen. George C. Kenney, commander of Far East Air Forces, predicted that 5,000 tons of explosives would be put on a single target, as compared with about 3,600 tons loosed on Germany.

Mining of the enemy's harbors had established a virtual state of blockade, and the B-29's had started to drop leaflets on the enemy's cities, naming the cities that were to be hit next and warning the populace to leave beforehand.

The road back from Pearl Harbor was a difficult one, but it was a job well done by all, both abroad and at home.

THERE'S MORE THAN MEETS THE EYE

Now that Japs have surrendered, it is possible to show how extensive camouflage was used after Pearl Harbor to conceal our west coast aircraft factories from possible air attack. Photo depicts Douglas Santa Monica plant completely hidden beneath realistic-looking fake housing project of false homes, wire and burlap, gardens and trees, and streets. In background can be seen Clover Field's camouflage-painted airstrip. It is stated that disguise was so well done that company pilots often couldn't find their way "home" after taking off so white markers had to be painted on hillsides to guide them. To add to illusion a dummy plant and airfield was built nearby. Camouflage is now being dismantled.

★ CANADIAN NOTES ★

By James Montagnes

Some assurance that Canada is to have a stable postwar aircraft industry is seen in Ottawa announcement that government-owned Victory Aircraft, Toronto, has been sold to Hawker-Siddeley Aircraft of London. Sale is stated to be conditional on establishment in Canada of research, design, and development branch. Canadian company is expected to make Avro Tudor airliners.

War Assets Corp. has advertised nearly 7,000 surplus engines for sale for private use, disposal being made to highest bidders. Makes include Gipsy, Cheetah, Jacobs, Menasco, Mercury, Pegasus, Perseus, and Merlin. Most are in new or slightly used condition.

Five Douglas Dakota (DC-3 type) transports have been flown to France for civilian use.

First Burnelli flying wing to be **built** in Canada is undergoing **flight** tests. Canadian Car & Foundry, Montreal, is licensee of Burnelli patents in Canada. Prototype, a passenger-freight craft to seat 24 passengers, is stated to contain 700 cu. ft. of cargo space. TACA has shown an interest in plane, which has been designed to use relatively short fields. Stated payload is 3–3½ tons, maximum speed 200 mph., and range is given as 2,000 mi. Passenger compartment is 20 ft. wide, with freight portion 20 ft. long and 6 ft. wide. Doors are 6 ft. wide to permit loading of autos, tractors, and long pieces. Craft has 86 ft. span. **Power is** furnished by two 1,200-hp. P&W engines.

A research department has been founded by RCAF for design of new military aircraft and for close cooperation with government-owned Turbo-Research, Ltd., Toronto. Britain is sending a Gloster Meteor to aid in study of jet-propelled craft.

TCA will soon begin international air service between Duluth, Minn., to Port Arthur-Fort William, Ont., with feeder routes to connect with its transcontinental route. Seaplane services to mining areas in Northwestern Ontario are also being considered . . . Airline has also arranged, under Two Freedoms clause of Chicago Air Conference, to use a bad-weather alternate route through Detroit, Milwaukee, and Minneapolis to Fargo and Winnipeg, in place of regular Toronto-Winnipeg hop . . . Company starts commercial trans-Atlantic service from Montreal to Great Britain this month using converted Lancasters, at rates stated to be competitive with other trans-Atlantic services.

Dominion is to announce its airport policy very soon, according to R. A. C. Henry, chairman of Canadian Air Transport Board. Meanwhile, CATB is making a survey of prospective airport sites.

THE WASHINGTON WINDSOCK

By BLAINE STUBBLEFIELD

The war ended with an abrupt and cataclysmic exclamation point—the atomic bomb. And as the potentials of this revolutionary new weapon began to be realized, a complete change in the manner of warfare was forecast, some experts holding that this revision will be more comprehensive than at any other time in history.

Problems which the A-bomb discovery may eventually pose are numerous. For one thing, it's conceivable that small belligerents, even renegade forces, might one day be able to stagger major powers with such missiles. These bombs may not always be so hard and costly to make.

Currently, the situation is weirdly unique. For these next few years—that is, until atomic demolition is mastered elsewhere—one group of nations will be packing the power to enforce its will virtually anywhere on earth. Such a period has never been experienced before and may never be experienced again. Of course, no one believes the atom-welding countries will use their advantage. Caesar, Napoleon, and Hitler, wherever they are, must be salivating at the thought of such supremacy.

Meanwhile, the grand curbstone debate is underway. Just cock an ear and you'll hear it. Sky power men: "It was air attack and air blockade that brought Japan to her knees and surrender." Surface power men: "Our Army and Navy really did the trick by fighting three years to move aviation up to bases from which it could strike." Atom power men: "Gentlemen, kindly let us horn in here. In the final analyses, wasn't it our disintegrating, vaporizing wallop that actually capped the climax and rang down the curtain on those Nippos?"

Fleets of American planes, held in occupied Europe, could have been used to speed regular troops back to the U. S., in the opinion of many air officers. The equipment, shuttling the Atlantic, could have been available for any emergency in a few hours. Mead war investigating committee intervened to have some of the planes released.

Germany was ready to drop all kinds of gas bombs on England, but didn't because advantage in gas warfare is all with the side having air superiority.

In a recent statement protesting CAB allocation of trans-Atlantic routes, Pan American made plain its dissatisfaction over defeat of its chosen instrument program by Congress and by Executive offices. It will bring up the issue again.

Labor Government in England will lean further toward nationalized airlines, which will be used as an argument for similar policy in the U. S., when the time comes. But meanwhile American competitive operations will have a chance to show their efficiency against England's government operations.

Banish Flight Fatigue

WARREN McARTHUR advanced technical seating, specified by engineers for more than 85 per cent of combat and long range transport airplanes in the war, is contributing so much to efficiency and comfort, necessary to victory, that peace time requirements of pay load, passenger comfort and economy make world wide adoption of this equipment almost imperative.

Twice as strong, with much less weight than any previously conceived, by virtue of a new fabricating technique and judicial designs from aluminum and magnesium . . . these seats, supercomfortable, easily adjustable, virtually banish flight fatigue.

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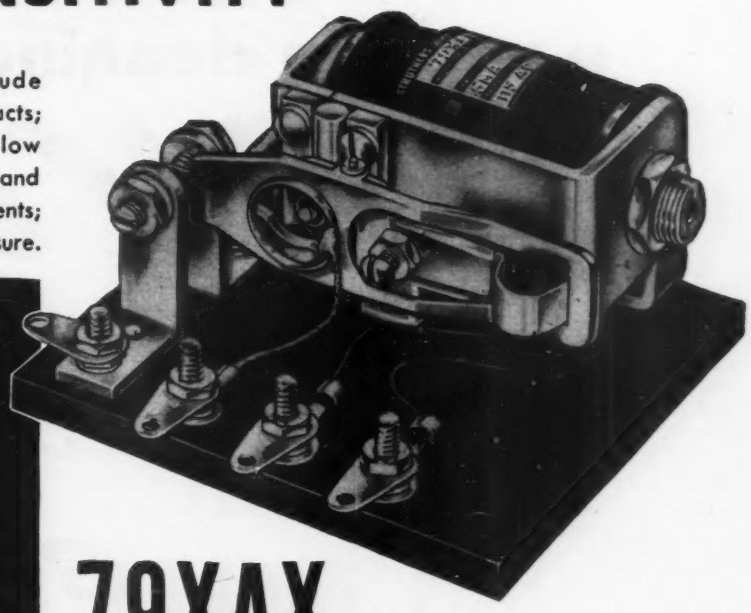
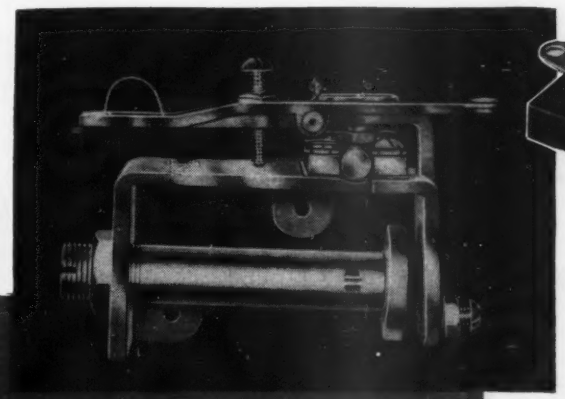
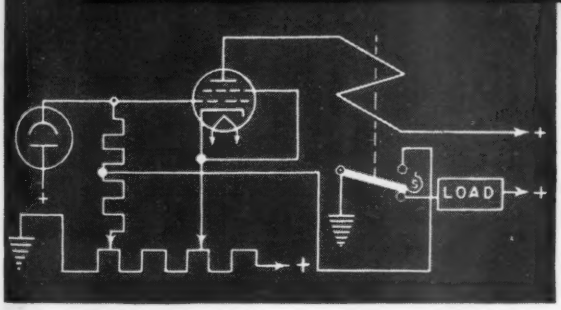
POSITIVE SNAP ACTION

0.02 WATT SENSITIVITY

SIMPLIFIED CONSTRUCTION ... Features include snap action contacts; high sensitivity; low operating power; statically balanced armature and contact assembly; six easily accessible adjustments; good contact wipe and stable contact pressure.







A typical vacuum tube application. A slight increase in plate current closes the relay, thus increasing negative bias on the amplifier tube so that plate current through the relay coil immediately decreases to a point close to the release value for the relay. Thus, any slight decrease in light falling on the photo cell will reduce plate current sufficiently to return relay contacts to normal position.

79XAX

Struthers-Dunn Type 79XAX snap action d-c operated relay is a positive acting sensitive unit that finds a wide variety of applications in circuits with slowly changing control currents. Erratic operation and varying contact resistance encountered with ordinary sensitive relays are eliminated. Applications for this popular relay cover a broad range of use from vacuum tube circuits, to overcurrent protection, pulsing circuits, and uses where extremely close differential or sensitivity of operation is required.

WRITE for Data Bulletin 79XAX giving full construction details and outlining a variety of suggested uses.

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5,312 RELAY TYPES

DISTRICT ENGINEERING OFFICES: ATLANTA • BALTIMORE • BOSTON • BUFFALO • CHICAGO • CINCINNATI • CLEVELAND • DALLAS • DENVER • DETROIT • HARTFORD • INDIANAPOLIS • LOS ANGELES • MINNEAPOLIS • MONTREAL • NEW YORK • PITTSBURGH • ST. LOUIS • SAN FRANCISCO • SEATTLE • SYRACUSE • TORONTO

THOUSANDS

a year on cleaning costs alone,

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SOLUBLE
METAL WORKING OIL
Think of it! Literally thousands of hard cash dollars saved on a single operation by new Shell Virgo Oil!
Here's how it happened: A West Coast manufacturer found that in the deep drawing of his aluminum parts a great deal of time and labor were being eaten up by having to use an elaborate system of washing in order to remove the drawing lubricant used.
Shell Lubrication Engineers were consulted. The result was new Shell Virgo Oil. A soluble, metal working oil entirely new. A lubricant that can be removed with warm water, leaving the metal surface clean enough to paint . . . one that combines excellent lubricating properties with high cooling efficiency, is non-corrosive, gives good rust protection with high wetting characteristics that makes it extremely economical to use.
Since their introduction scores of performance records have been broken by versatile, new Shell Virgo Oil. For full details on this sensational line of oils, write: Shell Oil Company, Incorporated, 50 W. 50 St., New York 20, N. Y. Or 100 Bush St., San Francisco 6, California.
Have you your E. C. Calculator?
If not, send to Shell today. It's free.
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NEW
SHELL VIRGO OIL

CAB Decides Non-Transport Airworthiness Requirements; New Categories Defined

. . . Plane price ceilings dropped . . . July output: 4,784 . . . Test jet-driven props; AAF officers visiting Lab . . . Uncover Nazi war secrets.

CAB reached a quick decision on questions relating to airworthiness requirements for non-transport craft, thus relieving manufacturers of difficult uncertainties in government design requirements.

A complete new text of these regulations (CAR Part 03) is adopted, but decision on the following points was given in advance: (1) Non-transport categories to be created at present will be limited to normal, utility, acrobatic, and restricted. There will be no personal category; (2) Maximum allowable stalling speed will be 70 mph. for single-engine aircraft of 6,000 lb. or less gross weight which fail to meet the single-engine climb requirement indicated in 4; (3) climb requirements will be at least 1:12; and at least 300 fpm; (4) multi-engine craft of over 6,000 lb. gross weight must have a rate of climb, with one engine inoperative, of at least 0.02 V^2so at 5,000 ft. with cowl flaps set for cooling on a hot day; and (5) the limit load factor for maneuvering in aircraft of the normal category will be 3.8, except that for craft certificated as characteristically incapable of spinning, for which this requirement will be reduced to 3.5.

Plane Price Ceiling Dropped

OPA price ceilings on new and used airplanes have been suspended. Suspension is not final, and if prices rise in an inflationary manner the controls will be put back on. Parts are included in the price schedules. Exceptions remaining under the price ceilings are tires, tubes, die castings, iron and steel and non-ferrous castings. Ceilings have been dropped because potential supplies exceed the demand. OPA is modifying its controls on lines which do not directly affect the cost of living or which will not contribute to inflation.

July Output: 4,784

Aircraft production in July fell to 4,784 units, as compared with 5,794 in June. July output was 243 units short of the 5,027 schedule. Month's production, said J. A. Krug, was below 4,800 for the first time since October 1942, and was nearly down to half of the wartime maximum output of 9,118 in March, 1944.

July airframe weight, minus spares, was 53.6 million lb., as compared with 65.3 in June, an 18% drop. The average workday rate dropped from 223 units in June to 184 in July.

Breakdown for July: 1,542 bombers; 2,193 fighters and Navy reconnaissance; 523 transports; 110 trainers; and 416 miscellaneous. Only the latter group was ahead of schedule.

While the industry did not meet some schedules in recent months it has been obvious that the government was not greatly concerned.

Test Jet-Driven Props; AAF Officers Visiting Lab.

Technologists at NACA's Cleveland laboratories are experimenting with multiple jets on propeller trailing edges. Compression of air for mixing with fuel would be by ram effect of blade speed, the air entering through vents in the leading edges of the blades. Fuel would be led into the propeller through a hollow shaft, and would be mixed with air inside the blades. The weight of the propeller would be somewhat increased, but power plant facilities in the plane would be almost eliminated. Propeller power output would be controlled by varying blade pitch and throttle, and it is stated that more or less constant speed at best jet efficiency would be maintained.

Cleveland laboratory is now visited by 60 AAF combat officers per month. Lt. Gen. Ira C. Eaker, deputy AAF Commander, stated three reasons why he wanted his officers to observe basic aeronautics research as a part of the redeployment routine: (1) Many of the officers have seen much Nazi aviation development and its results and get the impression that the U. S. was and is behind in all phases; (2) many have been so busy in operations that they have had very little time to learn about technology; and (3) some of them will become leaders of this country's air power in the very near future.

Uncover Nazi War Secrets

More than 200 technical experts investigating Nazi war secrets discovered many interesting developments. Among them: An airplane with a very high ceiling; flexible high-tension cables that carry double the voltage of former types of the same size; tungsten substitutes for making armor-piercing shells and cutting tools; catalysts for converting oil to high-octane aviation gasoline quicker than had been possible before; details on refinements in the gas synthesis method of producing liquid fuel from coal; and advanced information on high-temperature alloys.

★ ASSEMBLY LINES ★

Taylorcraft announced that production has begun on Model BC12, a two-seater, and on four-place Model 15. Quantity output of former is expected to be reached this month. BC-12 is to sell for $2,295 f.o.b., with latter type priced at $3,550 to $3,995 f.o.b. Full production of Model 15 is expected by December.

Allison is building jet-propulsion engines for U. S. Navy in addition to those made by company for P-80. Both are of basic GE design. Only information given on Navy's engines is that they are "of a different type from those for AAF."

Boeing has received an AAF contract for three models of C-97 transport. First model will be almost identical with cross-country record-breaker; second type will be troop-cargo carrier, with more powerful engines and other improvements; and third type will be similar to second, except that it will be fitted with airline-type seats.

Wright Aero's Wood-Ridge plant recently shipped its 10,000th Cyclone-18 engine.

Convair began modification of undisclosed number of B-29's at Tucson div.

Willy-Overland received another AAF contract for more jet-propelled "buzz bombs," as Pacific war ended.

Cleveland Div. of Borg-Warner has been making fuel pumps, booster pumps, and lubricating and hydraulic pumps for jet-propelled planes.

Eureka Vacuum Cleaner Co. is producing electric control motors for Eclipse-Pioneer air position indicator.

Republic produced 15,000th P-47 Thunderbolt. It is stated that since start of '44, P-47 output each month has represented about 15% of all AAF fighters made.

Final B-17 was produced—the 12,731st. Boeing made 6,981, Douglas 3,000, and Lockheed 2,750. After completing its contract, Lockheed cleared areas for increased Constellation production. Company likewise removed plant camouflage, a job estimated to cost $236,000.

★ KNOW HOWS ★

Compressed-air nut runner combined with automatic clamp has improved electric terminal nut alignment at Glenn L. Martin, also speeded operations.

Isothermal treatment of small parts, developed by Ajax Electric, is reported to have eliminated distortion during heat treatment.

Lucite containers by duPont are stated by Norden company to have prevented former corrosion of bomb sight bearings caused by faulty storage boxes.

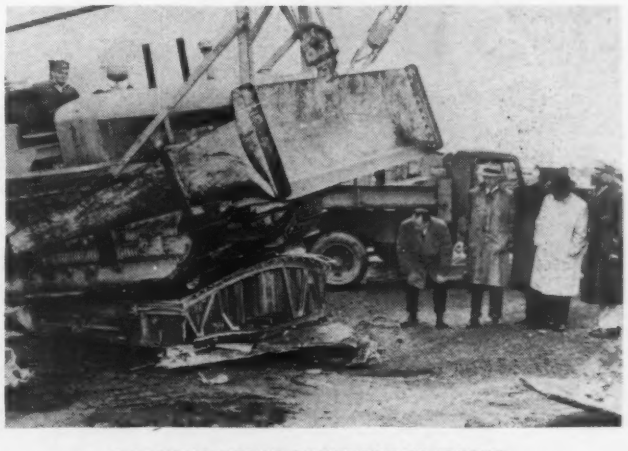
Using static-free FM, Battelle Institute has developed measuring instrument stated to be accurate to 0.0000001 in. Gerard M. Foley is inventor.

Electronic tympanometer is used by physicians to measure altitude effects on pilots, reports Westinghouse.

Solenoid-operated cable cutter, developed by GE shops, is reported to have greatly reduced operational time.

Oil-soluble blue dye, used by Convair to tint template drawing boards, is stated to have almost entirely eliminated draftsmen's eyestrain.

Job of installing cowl formers



B-24 WING SHOWS BACKBONE TO 'DOZER

Toughness of U. S. warplanes was amply demonstrated recently when officers of disposal section and officials of an aluminum company gathered to watch preparation of scrap metals for rail shipment. An eleven-ton bulldozer was run upon a Convair B-24's wing section in an attempt to crumple it, but failed completely when wing refused to cooperate.

Propeller Shaft Thrust Bearing Cover, manufactured for Pratt & Whitney airplane engines.

LAWSON MACHINE and TOOL CO.

120 MOUNTAIN AVENUE, MALDEN 48, MASSACHUSETTS

and air scoops has been switched by Douglas from production line to power plant dept., and change is credited with saving 4 hr. per plane.

By using 7,000 sq. ft. of 0.5 in. Fiberglas lining in C-97's, Boeing reports it has sound- and fireproofed plane's fuselage with saving of 225 lb. over other materials tested.

Hydraulic pressures up to 3,400 psi. are now used in testing designs of aircraft actuating cylinders, says Bendix Pacific Div.

Infra-red lamp banks, for expanding reduction drive gears, are stated by Studebaker to be more economical and efficient than previously used oil bath.

Color was put into use at Hobbs Army Air Field, Hobbs, N. M., to increase worker safety. Gears, saw blades, and other moving parts were painted yellow. Anything that might be considered a hazard was colored in an attempt to make it stand out.

★ FOR THE RECORD ★

L. G. S. Spring Clutch Corp., wholly owned C-W subsidiary, has purchased Mars Hill plant in Indianapolis, which has been operated by Allison div. of GM. All L. G. S. facilities and machinery are to be moved to newly acquired building.

Talon, Inc., has sold Aero Products Div., which made fiber self-locking stop nuts and cowling fasteners, distributed under trademark name Lion. New company taking over is known as Lion Fasteners, Inc. New company's location is to be announced later.

Aireon Mfg. Corp. has formed Mexican subsidiary known as Aireon, S. A., and has opened pilot plant and sales offices in Mexico City.

Interstate Aircraft & Engineering Corp., El Segundo, Calif., has sold to Harlow Aircraft Co., Alhambra, all engineering drawings, production tooling, and spare parts for Interstate's complete line of personal craft. Harlow expects to begin production of planes as soon as possible.

Michigan Dept. of Aero has opened sealed bids on construction of airport at Fremont, Newaygo County. Construction on project was expected to start as we went to press.

Intava has moved hq. from London to N. Y. C., where address is 25 Broad St. Organization coordinates foreign aviation marketing activities of Standard Oil Co. (New Jersey) and Socony-Vacuum Oil Co.

Institute of Aero Sciences has purchased building at 2 E. 64 St., N. Y. C., and will move from Rockefeller Center into new location this Fall.

Frederic Flader, Inc., 512 Sidway Building, 775 Main St., Buffalo, N. Y. is successor to Frederic Flader & Associates. Company is engaged in research and engineering of experimental internal-combustion turbine-type power plants.

Menasco having purchased Malabar Mfg. Co., maker of hydraulic jacks for aviation and other industries, will operate it as a div. of parent company.

Casey Jones School of Aero, N. J., and Academy of Aero, La Guardia Field, are consolidating their activities at La Guardia Field for Fall term. During 13 yr. of operation, schools have graduated over 20,000 students.

William J. Deed, naval architect, has opened new offices at 154 Nassau St., N. Y. C. A specialist in plywood and plastics, Mr. Deed has been consulting naval architect for Fairchild's Duramold Div.

Bauman-Rosin & Associates' partnership has been dissolved and activities of firm will be continued under name Morton A. Bauman & Associates, 214 Chester-Twelfth Building, Cleveland 14, Ohio. Company handles design, plant, and product engineering, research, manufacturing processes, and plant layout work.

Aircraft Tools Co., with offices in N. Y., Detroit, Wichita, and Dallas, is new organization for sales and distribution of products of Aircraft Tools, Inc., 1811 Hope St., Los Angeles. John A. Ruthven is mgr. of new firm.

New safety code for industrial use of X-rays has been completed by War Committee of American Standards Assn.

Curran Corp., Malden and Lawrence, Mass., maker of chemical cleaners for airmotive and other fields, have re-named its degreasers and decarbonisers. Product known as Gunk P-96 will now be called Gunk Spray, and Gunk H-S is to be called Gunk Dunk.

Fairbanks, Morse & Co.'s turbine pump advertising dept. has begun an intensive advertising-selling campaign to company's field organization, including branch offices, representatives, and distributors. Starting with pamphlet giving why, when, where, and how of concern's broad coverage, mail campaign will include ads in mat form and will induce distributors to use these ads in their local papers.

★ CALLING NAMES ★

Carl W. Clifford, Marshall E. Beeman, Roland Rohlfs, and **Lester B. Littrell** have been appointed CAA Regional Advisor-Consultants . . . **Dr. Irston R. Barnes** has been named Economic Advisor to CAB.

M. J. Madigan took **Lt. Gen. William S. Knudsen's** place on APB.

Irving B. Babcock was elected pres. of Crosley Corp.

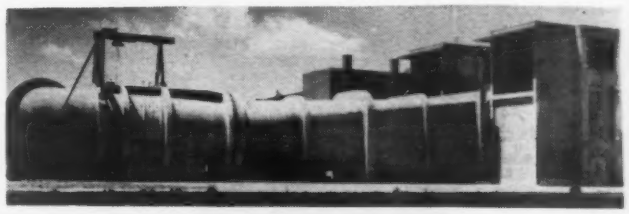
C-W appointments: **C. H. Augspruger** became public relations head of Airplane Div.; **Jack Anderson** became company's West Coast public relations representative; and **Gladding B. Coit** was named corp. treas.-comptroller.

Eric C. Sparling, Sperry chief engineer, ras received a 30-yr. company service pin.

AAF promotions: Named to rank of Lt. Gen.: **Ennis C. Whitehead,** c.o. of Fifth Air Force; **Mathew B. Ridgway,** c.o. of Eighth Airborne Corps; and **Nathan F. Twining,** c.o. of Mediterranean Air Forces. Made Maj. Gen. are: **Lauris Norstad, Michael M. Powers,** and **Harold M. McClelland,** Air Corps, also **Edward P. Curtis,** Air Corps Reserve.

Alec E. Ulmann resigned as pres. of Hub Industries to return to activities as export consultant and export mgr. for various aviation interests.

Peter Masefield, formerly of Britain's *The Aeroplane* and aviation consultant to British govt., arrived at British Embassy in Washington, D. C., to take up new post as Civil Air Attache.



UAC'S NEW CAVE OF WINDS

Company's recently completed wind tunnel, stated to be capable of testing power plant installations at air speeds of 200 mph., as well as reduced scale models of aircraft and propellers at speeds of 600 mph. Total length of tunnel circuit is given as 634 ft., and its largest cross section is approximately 35 ft. in height. Two alternate test sections are available, one with an 18 ft. throat diameter, and the other with one of 8 ft. diameter. Seen here is tunnel's east leg, with fan-motor foundation and maintenance hoisting equipment at left and air exchange towers at right.

UAL appointments: **H. E. Nourse** became v.-p. in charge of economic controls; **D. F. Magarrell** is new v.-p. in charge of passenger service; and **R. F. Ahrens** became v.-p. in charge of personnel; **Ray Conners** is N. Y. district publicity representative; **Warren A. Peterson** became supervisor of passenger relations . . . **Maj. Rudolph W. "Shorty" Schroeder** received DFC for his high altitude flying work of 25 yr. ago.

Richard DeHart Williams has been made WAL aero engineer, and **Robert Leinster** was named airline's supervisor of reservations and service.

Frederick F. Robinson, pres. of National Aviation Corp., was elected to board of Bell Aircraft.

Howard B. Hall has been named eastern representative for International Aviation Corp.

AEA appointments: **Lt. Col. Sanford L. Willits** became supt. of maintenance overhaul; **C. James Rutland** was made senior maintenance engineer; and **Charles S. Hayward** became safety engineer.

H. F. Hargrove has been appointed works mgr. of Convair's Ft. Worth Div.; and **C. W. Felker** became factory supt. of Vultee Field div.

R. O. Bullwinkle has been elected to NWA's newly created position of v.-p.-traffic; **L. S. Holstad** was appointed to Municipal Finance Officers Assn. of U. S.-Canada, which is making a study of finance and accounting procedures for use by private and municipal airports in this country; and **H. L. Cummings** has been named a member of Montana's Aero Commission.

E. Ellis Bentley has been appointed airport and construction engineer for Jacksonville, Fla.

George A. Irvin has been made TWA's asst. director of industrial engineering.

Taylorcraft elections: **Frederick T. Pendell** as engineer; **A. S. Ellis** as general mgr.; **George Webster,** works mgr.; **O. M. Bell,** sales mgr.; and **Macdonald Goodwin** asst. sales mgr.

Howard Kennedy has been promoted by PCA to asst. to v.-p.; and **Leigh R. Murphy** became N. Y. supervisor of operations.

Southern Aircraft Corp. elections: **J. R. McLean,** board chairman; **Willis C. Brown,** pres.; **A. Eugene Pattison,** v.-p.-treas.; **Frances H. Brown,** secy.; and **H. G. Humphreys,** asst. treas.

Harry E. Blythe, v.-p. and general mgr. of Goodyear Aircraft, received his 30-yr. service pin from company.

H. R. P. Lytle was elected pres. of Ohio Air Express Corp.

Alexander B. Royce retired as chairman of Airlines Committee for U. S. Air Policy to return to private law practice. **Joseph E. Casey** replaced Mr. Royce.

R. J. Lindquist, formerly with C-W, became financial v.-p. of Standard Oil of Indiana.

G. Edward Pendray, formerly asst. to pres. of Westinghouse, opened his own offices as counselor in management, public relations, and education.

E. O. Locher has been named v.-p. in charge of all branches of Pacific Airmotive Corp. . . . **Gunnar Edenquist** became v.-p. and asst. to pres.

John T. Plunket became Aerovias Braniff's asst. to pres.

Thomas B. Doe, Jr., became mgr. of Aircraft equipment sales div. for Vickers, Inc.

Edward W. Scott has been named a v.-p. of TACA; and **William V. McTaggert** has been appointed airline's N. Y. cargo representative.

PAA appointments: **Harold Gatty** joined Pacific-Alaska div.;

(Continued on page 219)

★ OBITUARY ★

Charles W. Loos, director and vice-president of Curtiss-Wright Corp. In latter capacity he was in charge of plant site acquisition in company's vast wartime expansion program. Previously, he was associated with Curtiss Flying Service in capacities of assistant treasurer, treasurer, vice-president, and as general manager.

Oswald Robert Gayford, British Air Commodore and long-range flight expert. Records he established included a non-stop air run of 5,340 mi. (1933) and a 7,162 mi. flight from Ismailia to Port Darwin (1935). He was recipient of Air Force Cross and Royal Aeronautical Society's Silver Medal.

Randall Chapman, glider expert and chief engineer, of Laister-Kauffman Aircraft Corp.

Alfred Frank, formerly president of National Parks Airways.

Ora M. Blaker, vice-president and general manager, of Wayne Pump Co.

Making a 40-ton shock "DISAPPEAR"!

When a Skymaster hits the runway, the tremendous landing energy of this huge plane quickly *"disappears"*. It's not an act of magic, but the shock-absorbing ability of Aerol landing gear that does the trick! . . . The remarkable stamina and efficiency of Aerols, which protect plane, crew, and cargo from landing shock, account for their universal acceptance for major types of aircraft. ◆ ◆ Our products, serving many industrial fields, are mentioned below. Whatever your needs, Cleveland Pneumatic engineers offer you the benefit of over 50 years manufacturing experience.

THE CLEVELAND PNEUMATIC TOOL CO., Cleveland 5, Ohio

PAA, PCA Protest Atlantic Decisions; First Operations Hoped For this Fall

. . . CAA administrator can designate airways . . . JATUC views airfreight problems . . . CAB circulates non-scheduled safety regulations . . . Postwar aviation labor oversupply seen.

In approving foreign operations by domestic airlines the Civil Aeronautics Board recognized creation of a disadvantage to PAA, which it compensated to some extent by authorizing PAA to enter the U.S.

However, PAA immediately petitioned the CAB to "correct" its decisions, which in effect restricted the company to Foynes, Ireland, and to Marseilles, while allowing TWA and AEA to reach into many European cities, and into Africa. At the same time PAA implied that it will continue the battle in Congress against competition in U.S. flag foreign service, even though the chosen instrument bill was recently defeated in Senate committee.

Also contesting the Board's rulings is PCA, which has been left out of the Atlantic awards. In a petition signed by President Monro, the airline contends that the record does not support assignment of a Moscow route to AEA, whose application did not include it. PCA, which did apply for a Moscow service, claims it is best able to operate the route at a profit.

These developments came as officials were trying to work out entry agreements with foreign countries, and were also trying for an equitable apportionment of about 20 four-engine Douglas C-54's (DC-4 type) surplus military transports, in the hope of getting Atlantic operations started this Fall.

It is believed that the Army and Navy will permit use of their ground facilities where necessary both here and abroad. "Two-Freedom" agreements between the U.S. and several other countries will come into play when operations start.

CAA Administrator Can Designate Airways

An opinion delivered by the Attorney General, upon request of both CAA and CAB, leaves the Administrator free to designate airways at his own discretion.

Counsel for CAA, months ago, concluded that the law requires the Administrator to designate airways for each and all scheduled route operations. The airlines for years have been taking short-cuts across "dog-leg" angles and around areas of congested military traffic. Many routes are flown by radio compass, where no routes exist.

CAB counsel contended that the Administrator could use his own judgment; that if the operation was considered safe, no airway need be created. The Attorney General's decision supported that view, and the opinion will be law unless changed by court action.

Airlines like the privilege of short-cutting airways, but they also like the protection that is provided by flight aids which must be established when an airway is designated.

JATUC Views Airfreight Problems

Joint Air Transport Users Conference, sponsored in Washington by NAA, revealed that not only the public but shippers themselves are expecting services that the airlines are not yet prepared to deliver.

Opinions were expressed that the air transport industry is right in seeking to lower its rates before going after future volume business.

Speakers dealing with transport of fresh fruits and vegetables pointed out that total movement involves 27 billion ton-miles yearly, and it might be a long time before air transport's maximum could make much difference. Nevertheless, it was stated that perishable farm products would be the nucleus of volume airfreight. A definite need for planes to deliver afternoon newspapers was stated by publishers.

Lack of return loads will be a continuing problem in some regions. Air shipment of mail-order goods depends entirely upon low rates. There will also be a need for simplicity in the publication of freight rate schedules.

L. Welch Pogue, CAB chairman, recently advocated an air parcel post system. He also favored all non-local first class mail by air, and said it would not add much to present volume.

CAB Circulates Non-Scheduled Safety Regulations

A new set of safety regulations covering all commercial non-scheduled aviation has been released by CAB for circulation among all interested parties.

Jesse W. Lankford, CAA safety bureau director, says that regulations incorporating the safety practices of responsible operators in this field probably would be best for all concerned.

The draft being circulated was not available for publication at this writing, but Board officials said they would take no action on a final version until they had complete reaction from the industry. These safety regulations should not be confused with the proposed economic regulations for non-scheduled services, which have not yet been filed.

Postwar Aviation Labor Oversupply Seen

There may be as many as 100,000 new jobs for pilots and other flight and ground personnel with the airlines and non-scheduled air transport and related services by the fifth postwar year. This is one conclusion reached by the Department of Labor in a study published in the Monthly Labor Review, in Washington.

However, the study also states that postwar jobs for skilled aviation personnel, though numerous, will be far too few to absorb the tremendous numbers of veterans and others who will seek positions.

There may be about 15,000 pilots and co-pilots with the airlines in five years, according to a somewhat optimistic forecast. There will also be many opportunities for aircraft mechanics, and other technicians, with non-scheduled flying services, flying schools, private companies using planes for business, airports and government agencies. An optimistic figure for pilot needs, other than the airlines, in the same period is about 22,000, including those who start their own businesses as charter pilots or fixed base operators.

Employment of mechanics, radio and maintenance technicians will also be small compared with the available trained labor supply. The maximum number of new jobs in this field is estimated at around 49,000 in five years. In contrast there are about 570,000 enlisted mechanics and maintenance men, of which about 15% are interested in getting civilian jobs in their respective fields of endeavor.

In addition there will be about 235,000 flight engineers, navigators, flight or ground radio operators, dispatchers, and meteorologists available, to compete for about only 9,500 new jobs in these branches of aviation.

Article concludes that the only jobs that will have more openings available than men will be positions such as airline stewards and aviation stock clerks.

ENOUGH ROOM FOR MA IN MARS

Graphic idea of ample space in Martin Hawaii Mars flying boat is gained in this layout of one of craft's cargo hatches fitted out as a living room. Company states that postwar passenger-cargo version will be very similar to those being made for Navy, and estimates that 52.5% of craft's 87½ tons gross weight will be available for useful load on cargo version, and 48.1% on passenger model. It is further estimated that, operating at two-thirds throttle, postwar version will carry 50,551 lb. payload for 2,076 mi. at 204.5 mph., or 12,692 lb. for 4,650 mi. at 213 mph.

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To protect interior parts from corrosion—Roxalin's Zinc Chromate Primer—recognized as surpassing all specification requirements.

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For insignia markings and color treatment of interiors and exteriors—Aeronautical Lacquers or Enamels.

To retain the polish of aluminum—Clear Aeronautical Lacquers.

For unaccessible areas subject to severe corrosion—Roxaprene, the corrosion resistant finish.

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The DC3's are coming home. After yeoman service as the C47 Army Transport they are ready to resume their peacetime job of transporting passengers and mails for the nation's airlines.

To speed the job Pennsylvania Central Airlines, one of the first to "contribute" planes to the war effort is the first to begin mass reconversion. Naturally they called on Roxalin's complete line of aircraft finishes. For whatever the requirement Roxalin has engineered a finish to meet it.

Any or all of the complete line is available for this important reconversion job. Write to Department 855 for complete information.

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INCORPORATED
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WATCH ROXALIN IN AVIATION

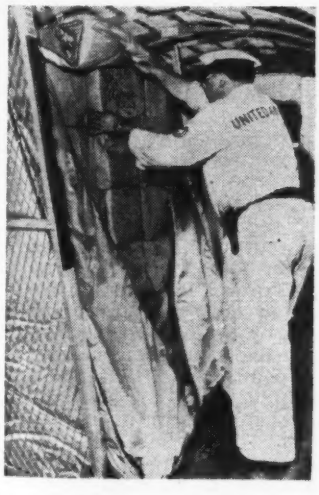
★ CROSS COUNTRY ★

UAL states that it is prepared to spend about $52,000,000 on expansion and improvement of flight and ground facilities as soon as conditions allow. Airline already has ordered 50 four-engine Douglas transports at about $25,000,000. It expects to spend another $7,000,000-$8,000,000 on more twin-engine equipment; plus $10,000,000 for the development, purchase, and adaptation of various war-born devices. Also projected was an equal amount for buildings and other ground work . . . Plans were also given out for another 4% reduction in passengers fares. Examples of proposed tariffs are as follows: N. Y. C.-Pacific Coast $119.10; Chicago-N. Y. C. $33.65, Seattle-Los Angeles $44.30, and Los Angeles-San Francisco $15.15.

AA announced it has placed orders with Douglas for 20 more DC-6 airliners. Previous orders were for 25 DC-4's and 30 DC-6's. Schedule calls for first DC-6 to fly in Mar. 1946, and deliveries may begin six months after . . . Air freight service has been expanded to include flights to and from Mexico.

U. S. Aviation Underwriters announces that airline passenger insurance is now available on American flag airlines in any part of world up to $100,000 at same premium rate in effect for domestic airline travel. Former limit was $25,000, covering only Western Hemisphere.

TWA gages N. Y. C.-Paris flight time at 15 hr. 15 min. for company's newly-certified routes, and it says that over-all time from N. Y. C. to Ceylon will be 46 hr. 5 min. Times are calculated on performance of Lockheed Constellation . . . Airline inaugurated three-stop service between west coast and N. Y. C. by revising schedules for Boeing Stratoliners.



PERISHABLE CARGO DONS COLD-CLOAK

This new and novel refrigerated container for airborne perishables is now under test in a UAL Douglas Cargoliner. Developed in cooperation with Owen-Corning, Fiberglas cloth and lightweight thermal insulated cargo container weighs but 25 lb. and has a capacity of about 120 cu. ft. Top has five pockets which hold slabs of dry ice. Container's walls are approximately one inch thick, and a zipper facilitates accessibility. It is stated that container's inside temperature dropped to 32 deg., which was maintained until dry ice was absorbed seven hours later.

ATA reports a new simplified passenger ticket form for long trips. New ticket, based on carbon-copy idea, permits agent to write all data for long distance ticket but once, which is possible because ticket is in a book form, with series of correlated coupons . . . It is stated by ATA that 19 domestic airlines have on order or option 409 new passenger craft. It is expected that airlines will increase cargo carrying capacity in immediate postwar years five-fold over 1944 level.

PAA states that traffic originating from Horta on Horta-Lisbon run jumped from almost nothing to near capacity when one-way fare was reduced from $106 to $45, and round-trip was fixed at $81 . . . Airline doubled service to El Salvador and added another flight to Costa Rica; also added were alternate route from Florida to Panama and new direct flights from Trinidad to Miami, plus extra service in Central America . . . N. Y. C.-Bermuda round trips reached 500 mark.

First complete aviation map of New York State is being printed by State's Bureau of Aviation. Map records 156 airfields, with legend indicating classification or runway length. Of these fields, 14 are under military control and 41 of remaining ports are municipally-owned or controlled. Class I fields total 59, and there are 26 Class II airports, 16 Class III, 9 Class IV, 2 Class V, and 30 Class Sub-I (for planes needing less than 1,800 ft. runway). Map can be obtained free by writing to Bureau of Aviation, N. Y. State Dept. of Commerce, 112 State St., Albany, N. Y.

Aerovias Braniff, S. A., began daily round-trip service between Mexico City and Merida, Yucatan, via Pueblo and Vera Cruz.

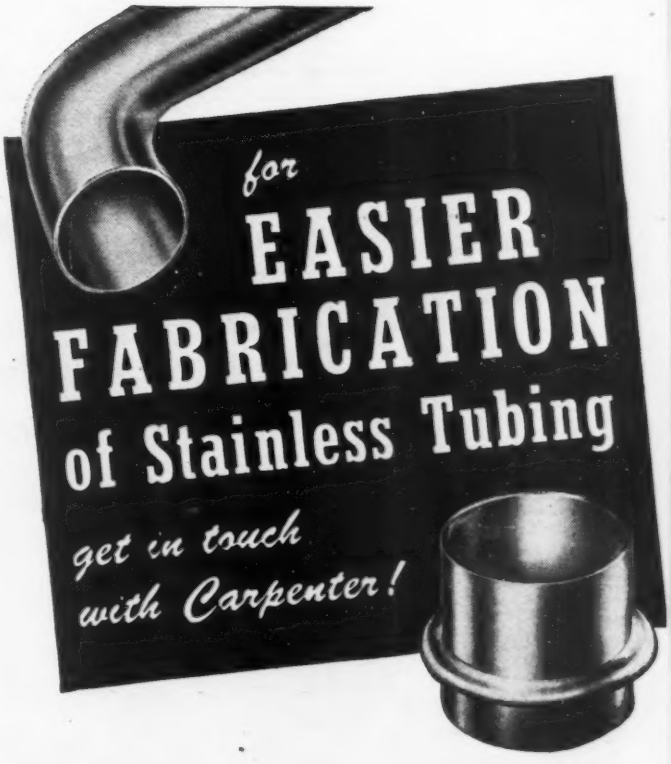
NAL has adapted a 14-passenger Lockheed Lodestar to carry 26. Increase was made possible by removing original seats and replacing them with upholstered benches equipped with arm rests and safety belts. Plane will be used by company subsidiary, Caribbean-Atlantic, which has received a 90-day foreign flight authorization from CAB.

NWA has added two more daily round trips between Minneapolis-St. Paul and Pacific Northwest.

Air Cargo Transport Corp. has been formed to handle an initial all-cargo airline set up to operate on a non-schedule basis to any airfield in U. S. Offices are in Empire State Building, N. Y. C.

Household furnishings of four families were recently flown from N. Y. C. to Los Angeles in a Convair 39 transport to test feasibility of air transport for long-distance moving. Load totaled 18,500 lb., including a piano and refrigerators. Cost of transportation was given as $20 a hundred pounds, or $3,700 total, which included trucking at both ends of trip. Cost is about 50% higher than rail costs, but one-day trip contrasted with about 30 days by train . . . An 18,500-lb. shipment of gas ranges was flown by same craft cross-country, and 17,500 lb. of produce were likewise flown from Salinas to Cleveland. Trips were carried out by AA, which has leased craft for three months to carry out such experiments.

Kanawha Airport, near Charleston, W. Va., is large new project now under construction. Job involves excavation of some 5,000,000 cu. yd. and three black-top runways, 5,000 and 6,000 ft. long, are to be provided.



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AVIATION ABROAD

BRITISH SEAFIRE XV AND NAZI JET-BOMBER

Royal Navy's latest carrier-based fighter, Supermarine Seafire XV, is shown (top) at moment of touching down on HMS Pretoria Castle. New craft, powered by a Rolls-Royce Griffon engine, features "sting-type" landing hook set in revised aft section of fuselage. (British Combine photo)

Above: Photo taken from captured German files shows an experimental Nazi jet-propelled bomber made by Junkers and designated Ju-287. Craft is fitted with four Junkers jet units, one on either side of fuselage and one beneath each wing. Fixed landing gear is enclosed in streamlined "pants" and is of tricycle type, with dual nose wheels. No information on craft's performance is available. (Aviation News photo)

★INTERNATIONAL BRIEFS★

ENGLAND — Bristol has produced over 6,000 Blenheims, more than 2,000 Beauforts, and more than 5,500 Beaufighters, utilizing over 150 plants with more than 55,000 employees.

BOAC is now flying 12,000-mi. route to Australia on a 63-hr. schedule.

DH Engine Co., subsidiary of DH enterprises, will concentrate on making Goblin jet engines and a new series of Gipsy models.

New British planes powered by Bristol engines are Short Shetland, Airspeed AS-57 (Brabazon II), Bristol 167, and Bristol Wayfarer (passenger version of Freighter).

Brabazon Va is Miles M-60 Marathon, and type Vb is DH-104 Dove.

BELGIUM — While little news has been available about activities of SABENA, official airline, regularly scheduled services to Congo are reported, with services to Paris and London in immediate offing.

NETHERLANDS—West Indies section of KLM will soon operate Douglas DC-3's on all major routes, including a new extension to Bogota, Colombia.

Fokker plants near Amsterdam were completely stripped of all equipment by Nazis, state reports from Holland. It is hoped that German equipment will be made available to reequip plants.

A special committee was formed in Amsterdam to coordinate surface and air transportation and eliminate detrimental conflict between rival interests.

USSR — While some military plane factories are turning to consumer goods production, other plane plants are building airliners for USSR's proposed air routes.

A new helicopter is described in Moscow reports as having two engines, two rotors and two propellers, giving craft a 100-mph. cruising speed.

Boris Rossinsky, Russian aviation pioneer, received order of Lenin and Order of Red Banner. One of Bleriot's pupils, he first flew in a glider of his own design 35 yr. ago, and has since tested over 1,500 planes.

NICARAGUA—Lineas Aereas de Nicaragua received government contract for freight, mail, and passenger services to all parts of country. R. E. Frizell is mgr.

SWITZERLAND — U. S. and Swiss governments signed reciprocal air transport agreements, under Chicago "Five Freedoms" pact, providing transit rights and airport facilities in both countries.

JAPAN—New enemy interceptor has been uncovered by U. S. technical experts. Named Shu Sui, craft is said to be rocket-powered and fired from a turntable ramp. Armament consists of two 20-mm. cannon. Speed is estimated at 520 mph., and endurance at 7 min. One-seat craft's climb is given as 39,370 ft. in 3 min. Span is about 20 ft.

FRANCE—Gen. de Gaulle's official plane, a British Avro York, made a trans-Atlantic test flight before General's official crossing to visit U. S.

SO-70 flying boats will be built in three versions, with gross weights ranging from 90-120,000 lb., and powered by either Gnome & Rhone radial or Hispano inline engines varying from 2,200 to 3,000 hp.

Air France opened service from Paris to Lisbon, via Madrid.

ITALY—An Italian airline has started priority-only services inside Italy, using Savoia planes.

INDIA—Indian government has announced that more than 11,000 mi. of air routes will be in operation as soon as conditions allow.

GERMANY—Potsdam decisions wrote an effective finis to all German aircraft production, use of aircraft for transportation, or training of personnel, through maintenance.

WORLDATA . . . . . By "VISTA"

Policies of Britain's new Labor government are being watched with interest in U. S., since campaign speeches indicated that major changes are in store for British aviation. Informants state that the recently discussed White Paper will probably be dropped in view of the new government's nationalization of transport attitude. BOAC's tremendous amount of experience, praised by the RAF, makes it fairly certain that this chosen instrument will be enlarged and made all-encompassing for international operations.

While nationalization will be new for England, similar steps were taken some time ago by Canada and Australia. In Canada it is a virtual fact, and in Australia, a bill creating a single airline has passed the House and is now before the Senate. It is expected that the proposal will be submitted to the Australian people in the next election, and if based on the semi-private company plan, it is believed that it will meet with approval.

Routes operated by Railway Air Services in Britain came under attack, as did a proposed service by Scottish Airways duplicating many of RAS routes. Main contention appears to be slow planes used by RAS and high fares, about three times comparable rail rates. It is pointed out that present schedules to Glasgow only beat the crack Coronation Scot's 1939 schedule by an hour, while the service to Liverpool takes nearly five hours, longer than by train. Editorials have been pointing out that under these conditions there is little inducement for the railroads to operate and pioneer cheap, fast air transport.

British plants are preparing for Fall delivery of new commercial aircraft. First customer is reported to be Danish DDL, operating routes to Stockholm and Gothenborg with Douglas DC-3's allocated from U. S. surplus. Test flights are planned using converted B-17's as did Swedish SILA, but modern airliners are needed. Danish representatives have been promised Tudor I's for November delivery, with extremely liberal financing thrown in.

The airport at Amsterdam (Schiphol) was extensively damaged by aerial bombardments, and repairs will probably take till the end of the year. Now projected as a port of call for our new AEA-AA line, this field was generally considered one of the best in Europe, with an area of 525 acres, of which some 75 were concrete surfaced. Since the airport lies some 30 ft. below sea level, it had been drained by 156 mi. of special pipes; damage to this system and to the pumping stations is mainly responsible for the port's long disuse.

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GIANT PLANES that will speed across tomorrow's skyways are dreams no longer. You will be seeing them more and more frequently . . . great ships like Boeing's new Stratocruiser now in service as the C-97. When peace comes, it becomes a high-speed, low-fare transport for more than 100 passengers. As a luxury sleeper plane, it will have 72 seats or 36 berths on the upper deck, and a lounge, dining salon, crew quarters and cargo space below. It has a top speed of 400 miles per hour and can fly 3500 miles.

Planes like the Stratocruiser, equipped with PESCO precision-built products, are typical of many military developments which will be ready to serve in other fields. PESCO experience in meeting the exacting demands of military aviation will be available not only to commercial aviation, but also to industry in more effective applications of Pressurized Power and Liquid Flow. For descriptive literature, write PESCO Products Company, (division Borg-Warner) 11610 Euclid Avenue, Cleveland 6, Ohio.

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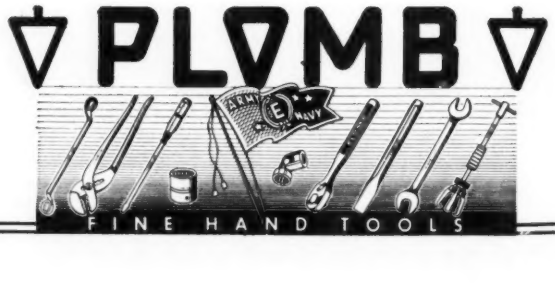
Together they mean better, safer, longer-lasting service from the tools you use, and a source of supply where you can buy with confidence—Plomb Tool Company, 2221 Santa Fe Avenue, Los Angeles 54, California.



A block of 100,000 shares of TACA has been placed privately in United States through New York brokers. This stock was obtained from Lowell Yerex, company president, who is understood to retain 200,000 of 775,000 shares outstanding.

Luscombe Airplane Corp. reports second quarter sales of $2,333,286, against sales of $948,375 in like 1944 period, according to Pres. Klotz. Six months sales were $4,270,680, against $1,877,082 in same 1944 period.

Glenn L. Martin Co. reports net profit for six months ended June 30 of $4,747,593 equal to $4.22 a capital share. Net sales were $195,867,196.

Douglas Aircraft Co. reports net income of $3,299,000 for six months ended May 31, equal to $5.50 a capital share. Net sales were $439,845.000 with 98% produced on a cost-plus-fixed-fee basis. Company's profit was stated to be less than 0.8% of sales.

National Aviation had net assets per share of $23.34 on June 30, against $19.03 a share on Dec. 31, 1944. Pres. Robinson revealed that holdings in aircraft and accessory securities increased to 44% of total assets on June 30 from 38.6% at year-end. Market value of aircraft and accessory stocks was $5,136,000, compared with an average cost price of $3,599,000, while market value of airline holdings was $4,531,175 against cost of $2,023,000.

Air Investors, Inc. reports net assets of $1,319,829 or $4.81 a share on June 30, against $1,121,613 or $3.80 a share on Dec. 31, 1944. On June 30, 1944, net assets were $1,097,000 or $3.39 a share.

Pennsylvania-Central Airlines reports net income of $411,549 or 87¢ a share for six months ended June 30, against net income of $66,463 or 14¢ a share in like 1944 period. Operating revenues were $4,764,425 against $2,275,180.

ADDING IT UP.....By RAY HOADLEY

Came the Curtain. Finale of hostilities meant finale for the big war-order business. There'll now be reconverting of the accounting ledgers.

Last But Not Least. Curtiss-Wright—last of the major aircrafts to issue its 1944 report—reports the amazing sales volume of $1,716,935,176, compared with $1,295,236,317 in 1943. This is the largest volume of war work produced by any single company in one year, yet earnings amounted to only .8% on sales and totaled $14,331,062 or $1.61 a common share against net earnings of $12,883,347 or $1.42 a share in 1943. Taxes stood at $88,000,000, a sum that eventually will be reduced by $8,520,000 through a postwar refund.

Airline Spending. Another wave of airline equipment buying started late in the summer, with American Airlines planning to spend between $5,000,000 and $20,000,000 for 25 to 100 new transport planes and United Air Lines allocating another $8,000,000 for additional planes to complete its $52,000,000 expansion program. Less is heard of airline expenditures for other facilities, but it is known that the lines will spend some $60.000,000 on hangar construction at New York's new Idlewild airport.

New Type Loan. Transcontinental & Western Air has financed the reconditioning of five Boeing Stratoliners by means of a $1,700,000 chattel mortgage loan from nine banks. Features of the loan are that it will mature in 5 yr., payable in 20 installments, with an interest rate averaging less than 2%. Based on 85% of net depreciated value of the collateral, it contains liberal provisions for substitution of collateral, and it may be repaid anytime without penalty. Knowing that TWA would need to start a financing program this year, the financial district was interested in the type of loan it chose.

Dividends. Airline dividends are increasing, while those of the aircraft manufacturing companies are declining, as forecast here last month. Pennsylvania-Central Airlines declared its very first dividend (25¢ a share) last month. At the same time, dividend payments of 24 aircraft stocks listed on the New York Stock Exchange amounted to $10,926,000 in the first half of 1945, compared with $11,229,000 in the like 1944 period, a decline of 2.7%.

Re 1945 Operations. A glimpse of how 1945 operations are running for the aircraft companies is shown in reports for the first six months made by Douglas Aircraft and by the Glenn L. Martin Co. These are the first interim reports these companies have issued since the war began. Douglas showed a decline of nearly 35% in unfilled orders, which stood at $1,052,796,000 on May 31 compared with $1,612,059,000 on Nov. 30, 1944. New orders amounted to $575,125,000, of which $111,772,000 were received in the second quarter. Cancellations totaled $694,543,000, of which $631,758,000 came in the second quarter.

Curtiss-Wright Corp. had current assets of $706,884,032 and current liabilities of $633,458,228 at end of 1944. Postwar refund of excess profits taxes totaled $25,601,000, and reserves for postwar contingencies were $32,831,000.

Solar Aircraft Co. reports net income for fiscal year ended Apr. 30 of $640,590 or $1.65 a share, compared with net income of $640,647 or $1.91 a share on a smaller capitalization in preceding year.

Irving Air Chute Co. reports 1944 net income of $263,019 or $1.33 a share, compared with net income of $291,481 or $1.47 a share in preceding year.

Bendix Aviation Corp. has announced it will manufacture a complete line of radios and radio-phonograph combinations on Pacific Coast.

Sherman M. Fairchild recently sold 1,000 shares of Fairchild Camera & Instrument Co., reducing his holdings in stock to 80,970. Other sales by Mr. Fairchild were 3,800 shares of Fairchild Engine & Airplane Co., leaving 217,927 retained, and 2,700 shares of Pan American Airways Corp., leaving 20,000 held. J. E. Swan, director of Piper Aircraft Corp., sold 19,682 shares, retaining 9,300 shares.

National Airlines is listing 20,850 additional shares on N. Y. Stock Exchange to be used in acquisition of 80% of 41,700 outstanding shares of Caribbean Atlantic Airlines.

Aviation Corp. will finance its purchase of a controlling interest in Crosley Corp. through a $25,000,000 bank loan, which will be paid in three equal instalments at end of third, fourth, and fifth years of loan.

Atlas Corp., as a result of its underwriting agreement with PAA, has exercised its privilege of purchasing 100,000 shares of stock in lieu of taking a cash settlement of $583,000. Atlas also has rights to buy another 100,000 additional shares.

Aviation Corp. reports net income of $1,593,260, equal to 27¢ a share, for six months ended May 31, against net income of $2,317,853 or 40¢ a share in like 1944 period. Net sales were $19,914,000, compared with $33,902,000 in same 1944 period.

United Air Lines reports net income of $3,541,785, equal to $2.20 a common share, for six months ended June 30, against net income of $2,924,837 or $1.79 a share in like 1944 period. Pres. Patterson said that profits for period would be reduced to $1,799,791, or $1.04 a share, in event company's airmail rate is lowered from 60¢ to 32¢, figure named in a CAB show-cause order.

★ CALLING NAMES ★

(*Continued from page* 211)

Glen Lawrence is company's new senior representative in Port of Spain, Trinidad; and **James M. Condon** became asst. operations engineer for Latin America.

Robert C. Storment, formerly with Lockheed, has joined Aireon; and **Robert E. Renner** was made asst. treas. and general controller.

Joseph H. Cassen has been named AA's supervisor of international information.

O. E. Esval, director of aircraft and marine instrument research for Sperry, and **P. Halpert,** company flight control research engineer, have been awarded National Prize by American Institute of Electrical Engineers.

Carl O. Hoffmann was elected to Colonial Airlines board.

Dr. Sanford A. Moss, GE consulting engineer, received Holley Medal for 1945 awarded by ASME.

Russell H. Whempner became sales mgr. of aero div. of Minneapolis-Honeywell.

Walter F. Chappel has been named Dayton representative at Wright Field for Hamilton Standard.

ATSC appointments: **Col. Kenneth H. Bitting** became chief of administration at Wright Field; **Col. William S. McDuffee** has taken command of eastern district; **Col. Turner A. Sims,** chief of administration, has been transferred to Washington, D. C.; and **Maj. Kenneth B. Wolfe,** chief of engineering and procurement, has gone to Pacific Theater.

Brig. Gen. Edward M. Powers, Asst. Chief of Air Staff, Materiel and Services, has been appointed by President to membership on NACA.

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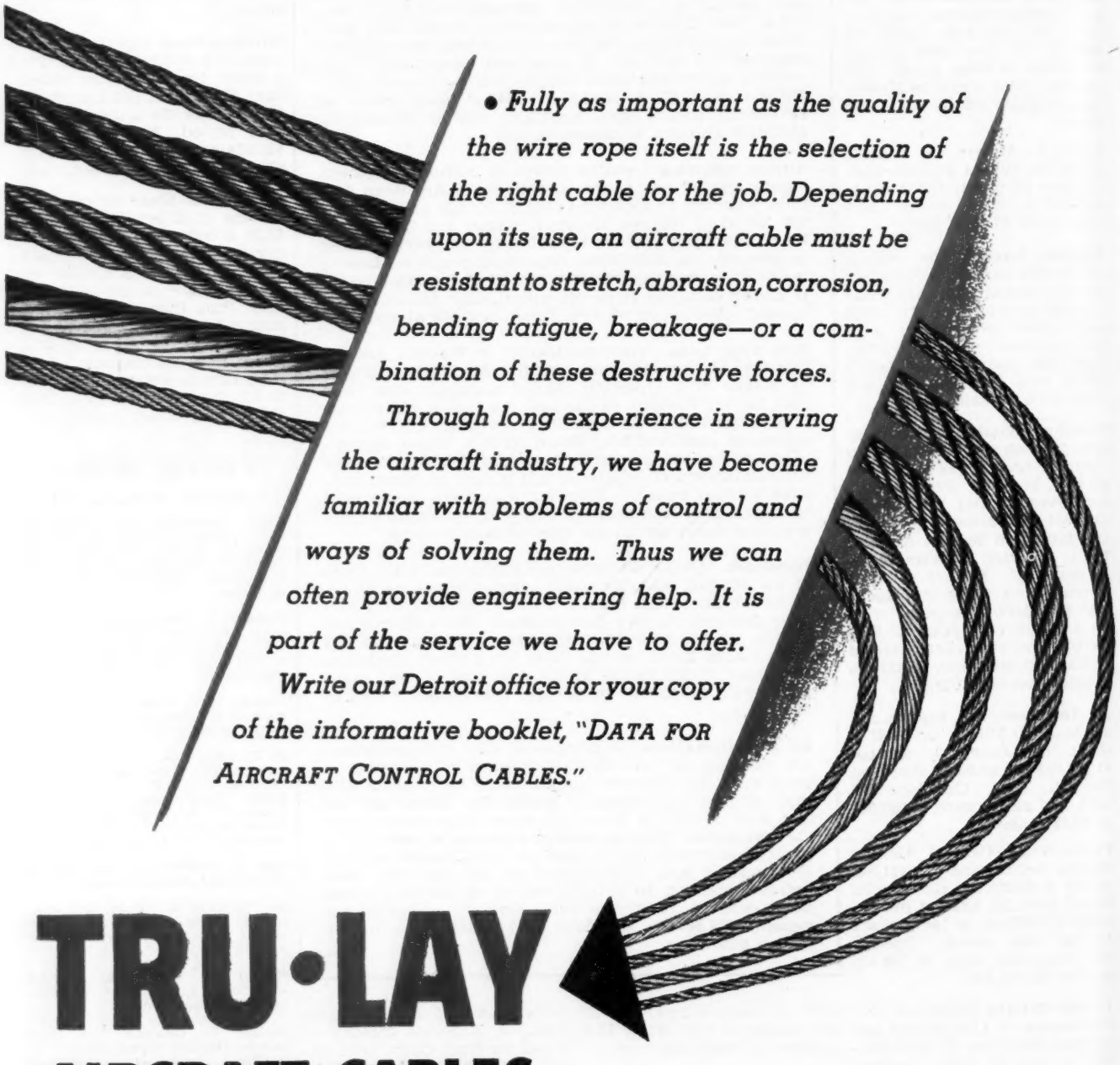

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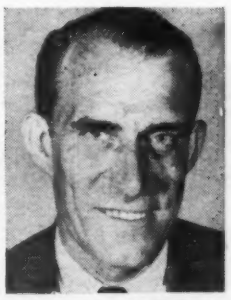
ERNEST G. WHITNEY was appointed asst. chief engineer of Ranger Aircraft Engines Div. of Fairchild. Formerly asst. executive engineer of NACA's Cleveland laboratory, he had been with NACA for nearly 18 yr., initially joining engine research section at Langley Field.

MURLIN C. ARNER has been made operations supt. of PAA's Latin American div. Joining airline in 1929, he has worked at company bases in Trinidad, Dutch Guiana, Dominican Republic, and Jamaica. In 1943 he became senior representative at Port of Spain. He is based in Miami.



GREGORY J. BRANDEWIEDE has been made director of sales for C-W Airplane Div. He entered aviation industry soon after World War I, when he joined Robertson Brothers in St. Louis. In 1926 he helped survey St. Louis-Chicago air route when company received one of early commercial airmail contracts. Joining Curtiss Aeroplane & Motor Co. in 1927, he went to St. Louis following year to enter Curtiss-Robertson Co., and in 1942 he was made general mgr. of C-W's Louisville plant. NATHAN F. VANDERLIPP (center), became executive engineer for C-W Airplane Div., supervising all engineering operations in Columbus, Buffalo, and Kenmore plants. He has been associated with Witteman Aircraft, Wright Aero, Fokker Aircraft, Bellanca, and Fairchild in Canada. JOHN J. LEE (right) has been made general mgr. of company's Buffalo and Kenmore plants. He first joined Curtiss in 1917.

K. R. FERGUSON has been elected to newly created post as NWA vice-pres. of engineering and postwar planning. Under his direction, airline's staffs organized and operated company's wartime projects. He is now chairman of operations committee of ATAA. LINUS C. GLOTZBACH (right) joined NWA's general administrative staff as exec. asst. to pres. Coming to airline in 1942 from a WPA executive post, he directed staffing of airline's war projects. A Notre Dame university law school graduate, he practiced law for 15 yr. He directed staffing of all of NWA's war projects, with personnel reaching 10,000 at peak.

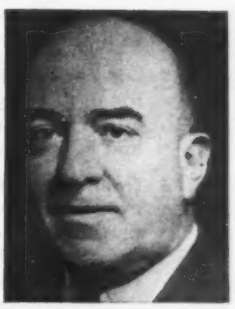
JOHN B. WALKER has resigned as vice-pres. of Aireon to head his own firm, John B. Walker & Associates, public relations counsel with offices in N. Y. C. Active in aviation and sales organizations, he has held executive posts with TWA, UAL, and EAL. He is also director of several firms.

MISS CARLENE ROBERTS was elected asst. vice-pres. of AA. Joining airline in 1938, she later organized movement of personnel and general hq. from Chicago to N. Y. C. when airline transferred offices to La Guardia Field. She will retain her Washington, D. C. hq. She became asst. to v.-p. in '42.

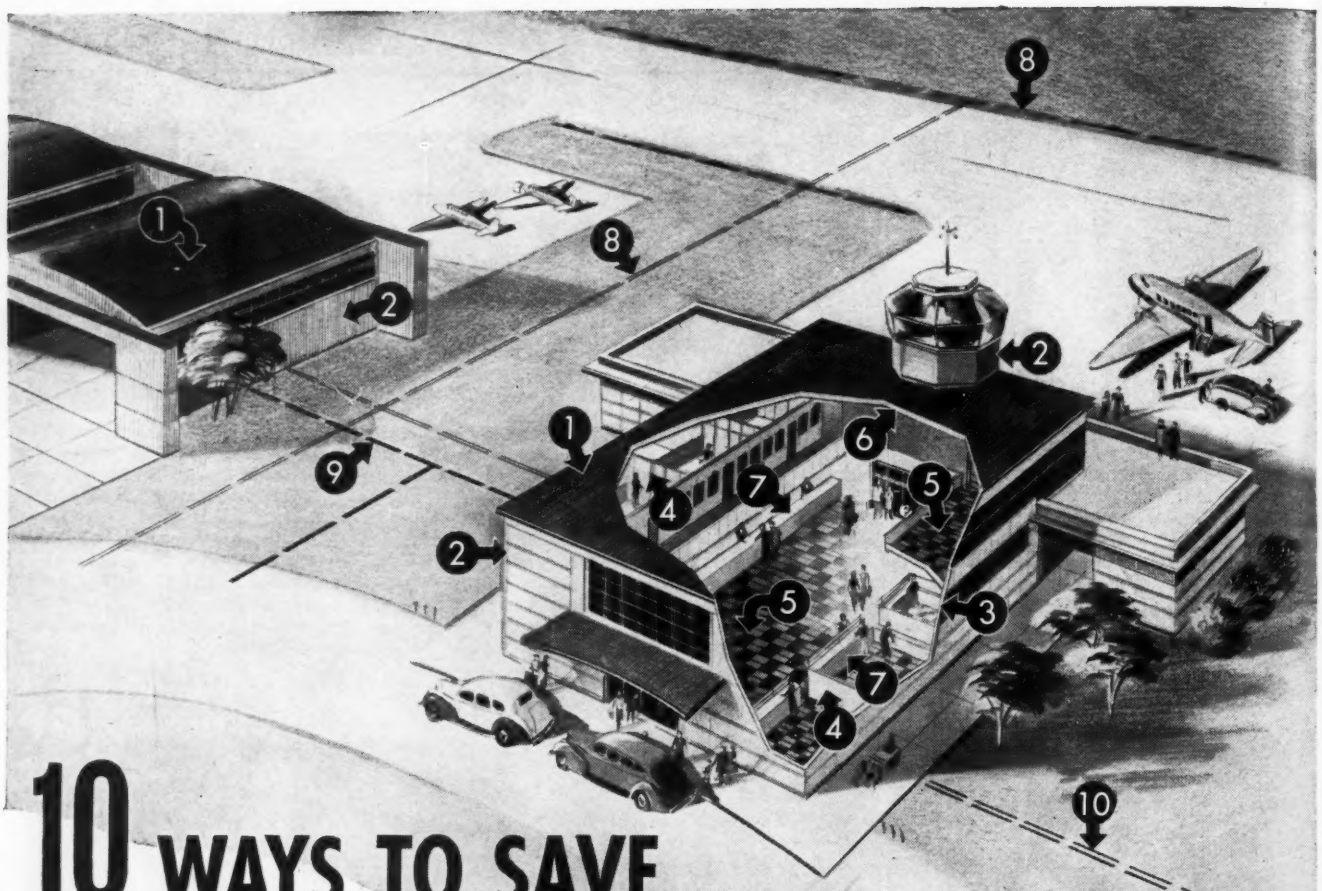
ARTHUR W. JERREMS has been named UAL supt. of merchandising. He will make his hq. in Chicago. Since 1943 he had been supervisor of program development on airline's Chicago educational service dept. He joined airline in 1940 as mgr. of sales in airline's Chicago office.

ALBERT J. EARLING has been named vice-pres. of traffic for Chicago & Southern Airlines. He joined airline early this year as asst. to pres. A native of Chicago, he is a graduate of Hotchkiss and Yale. It is stated that this appointment does not entail any changes in existing offices of traffic dept. H. R. BOLANDER, JR. (center) became vice-pres., administrative, this office having been set up to expedite and coordinate policies and functions originating in president's office. Early this year he was made vice-pres.-general counsel. He joined airline in 1941. A native of San Francisco, he attended University of California. RICHARD S. MAURER (right) has taken over office of airline's asst. general counsel and secy. Formerly asst. to Mr. Bolander, he joined C & S early in 1937, coming from CAB where he had served as general counsel to Certificate Unit.

COL. M. M. FROST has been elected a vice-pres. of EAL. He was called to AAF duty in 1942, and assignments took him overseas. He also had been connected with Readjustment Div., ATSC, Wright Field, and likewise had been active at one time in Florida aviation associations.



F. L. HOLSER was elected executive vice-pres. of Interstate Aircraft & Engineering Corp. He joined company as consulting engineer in 1938, served as plant mgr. of Wilshire div., and later he became vice-pres. of DeKalb, Ill., div. He is a graduate of University of Missouri.



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ENGINEERING DATA

Synthetic Rubbers 1

Technical aspects of synthetic rubber utilization in industry are covered in bulletin from Hycar Chemical Co., Akron, titled *Everywhere In Industry.*—AVIATION, Sept., '45.

High Quality Gears.....2

Engineering data, comparative performance curves, design details, and operating speeds of AQ (aircraft quality) gears are contained in engineering bulletin from Foote Bros. Gear & Machine Corp., Chicago, AVIATION, Sept., '45.

Lock Control Unit.....3

Engineering drawing, specifications, and description of new tension lock-control designed for positive locking on difficult control jobs, are contained in Bulletin No. 10, from Arens Controls, Chicago.—AVIATION, Sept., '45.

Aluminum Castings 4

Information for the design engineer and production man is contained in Bulletin PMC 45, from Permold Co., Medina, Ohio, on permanent mold castings of aluminum. Tables give nominal composition and physical properties of "Permold" alloys.—AVIATION, Sept., '45.

Perspective Drawing Machine.....5

Information is available on Stereograph perspective drawing machine, described as producing a perspective view as stereoscopic pairs showing length, width, and depth or, if desired, as a single perspective drawing, reducing substantially time and cost. In addition, drawings may be made to scale. Machine is also stated to produce third dimensional graphs, create space curves, and to be applicable for showing internal construction of complex mechanisms. Maker is Pomeroy Stereograph Co., Cleveland.—AVIATION, Sept., '45.

Equipment and Engineering Data.....6

More than 1,600 products of Allis-Chalmers, Milwaukee, are listed in new directory. Also listed are engineering bulletins covering many of these items, containing operating data, charts, and technical information.—AVIATION, Sept., '45.

Printer-Developer 7

Combining both printer and developer in one machine, new Model 41 unit made by Charles Bruning Co., Chicago, is designed for medium quantities. It is described in pamphlet.—AVIATION, Sept., '45.

PRODUCTION

Accessories Manuals 8

Eclipse-Pioneer Div., Bendix Aviation Corp., Teterboro, N. J., announces series of service manuals on company's aircraft accessories and equipment, covering installation, service, maintenance, and overhaul.—AVIATION, Sept., '45.

Chemical Bath 9

For preparation of aluminum for spot welding, Process K-1-B, material made by Kelite Products, Los Angeles, is described in bulletin.—AVIATION, Sept., '45.

Molded Fabric Bearings.....10

Listing performance reports and describing advantages, brochure from Gatke Corp., Chicago, illustrates numerous types and sizes of fabric bearings molded to required dimensions without machining.—AVIATION, Sept., '45.

Wire Rope Clamp.....11

Circular from National Production Co., Detroit, describes advantages and safety features of "Safe-Line" clamps for use on wire rope in place of bolts and nuts.—AVIATION, Sept., '45.

Pressure Sealing Zipper.....12

Applications to aircraft of pressure sealing zipper made by B. F. Goodrich Co., Akron, are given in folder, *New Openings For Tomorrow's Aviation,* in which it is stated that construction will not allow passage of gases or liquids, even under high pressure.—AVIATION, Sept., '45.

Production Brazing 13

Subject of mass production brazing with "Easy-Flo" is covered in *Low Temperature Brazing News No. 32,* from Handy & Harman, New York City.—AVIATION, Sept., '45.

Rubber Products Catalog.....14

Manhattan Rubber Mfg. Div., Raybestos-Manhattan, Passaic, N. J., has issued condensed catalog of mechanical rubber goods, titled *Manhattan Rubber Products for Industry.*—AVIATION, Sept., '45.

Welded Assemblies Service.....15

Facilities of Ampco Metal, Milwaukee, for fabrication of assemblies made of bronze sheet, castings, or extruded parts welded with "Ampco-Trode" aluminum bronze weldrod, are described in bulletin, *Welded Assemblies Fabricated At Ampco.*—AVIATION, Sept., '45.

Clamps 16

Folder is available from George K. Garrett Co., Philadelphia, describing Diamond "Multi-Clamp," made in 18 standard sizes and having many uses in aviation field.—AVIATION, Sept., '45.

Welding Rods and Fluxes.....17

Production Ideas, new pamphlet from Eutectic Welding Alloys Co., New York City, discusses company's postwar plans and application of its special alloys in various fields.—AVIATION, Sept., '45.

Powder Metallurgy 18

Information on powder metallurgy, design recommendations, and technical data, are provided in brochure issued by Moraine Products Div., General Motors Co., Dayton, Ohio.—AVIATION, Sept., '45.

Protective Packaging Material.....19

"Liquid Envelope," a peelable plastic material used to coat aircraft and other products and parts for protection during shipment, is described in booklet from Better Finishes & Coatings, Inc., Newark, N. J. Current and postwar applications are suggested and included is sample of plastic on a bit of metal sheet.—AVIATION, Sept., '45.

Screw Thread System.....20

Providing increased strength and protection to threads in light metal, "Aero-

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NEW PRODUCTS: 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110

NAME..... TITLE.....

FIRM OR AFFILIATION.....

ADDRESS .....

Thread" screw thread system, developed by Aircraft Screw Products Co., Long Island City, N. Y., is described in folder.—AVIATION, Sept., '45.

Wool Felt 21

Publication, *Felt Facts*, is now being issued frequently by Felt Assn., New York City, to publicize new and varied uses of wool felt.—AVIATION, Sept., '45.

Felt Gaskets 22

Containing samples of felt gasket and packing materials, Folder No. 41-A, from Felt Products Mfg. Co., Chicago, describes materials and suggests applications.—AVIATION, Sept., '45.

Shop Equipment 23

Ready-to-ship equipment designed to improve production, inspection, and research facilities, is listed in folder from Precision Equipment Co., Chicago.—AVIATION, Sept., '45.

Industrial Diamond Setting.....24

Information on new "Castweld" method of setting industrial diamonds, together with catalog of tools and diamond wheels, is available from Precision Diamond Tool Co., Elgin, Ill.—AVIATION, Sept., '45.

MACHINERY & ACCESSORIES

Running-Time Recorder 25

Instrument for recording running-time of machine is described in Bulletin No. OP1502 by Bristol Co., Waterbury, Conn.—AVIATION, Sept., '45.

Gas-Fired Furnaces 26

Circulars from Lindberg Engineering Co., Chicago, give description and specifications on gas-fired furnaces for tool room, production, and brazing.—AVIATION, Sept., '45.

Projection Welder 27

Current flow and heating during welding stage are localized at predetermined points—generally projections or embossments—and forging pressure is obtained in new 150 kva. projection welder made by Sciaky Bros., Chicago, and described in circular.—AVIATION, Sept., '45.

Soldering Unit 28

Designed for speedy production on intricate work such as in electronic field, "Arc-Melt" soldering unit, made by Wyse Laboratories, Dayton, Ohio, is described in pamphlet.—AVIATION, Sept., '45.

Adjustable Cutting Tools.....29

Robert H. Clark Co., Beverly Hills, Calif., with addition to plant increasing its production facilities by 10,000 sq. ft., now offers new catalog covering entire line of adjustable cutting tools.—AVIATION, Sept., '45.

Centrifugal Pumps 30

Written for benefit of those interested in centrifugal pumps who are not engineers, booklet from Deming Co., Salem, Ohio, contains information aimed to enable proper choice of pumps for specified applications.—AVIATION, Sept., '45.

Lathe Catalog 31

Engine and tool room lathes (9 in.) are shown in full color and described in new catalog from South Bend Lathe Works, South Bend., Ind.—AVIATION, Sept., '45.

Inspection Laboratory 32

Issue No. 110 of *Precise Production*, publication of George Scherr Co., New York City, contains article describing "limited budget" inspection laboratory installed and used by Atlantic Gear Works.—AVIATION, Sept., '45.

Vertical Turret Mill.....33

Catalog from Rogers Machine Works, Buffalo, illustrates vertical turret mill set-ups for boring, turning, and drilling, and describes machines.—AVIATION, Sept., '45.

Shop Microscopes 34

Bulletin from Polan Industries, Huntington, W. Va., describes small and sturdy microscopes for shop use in inspection of surface finishes and damages, for measuring dimensions smaller than 0.1 in., for inspection of welded joints, and checking of small precision tools and parts.—AVIATION, Sept., '45.

Gear Cutters 35

Complete line of form tools and relieved-form cutters for gears, threads, worms, and other forms, is described in Bulletin No. D-45 from Colonial Tool Co., Windsor, Ontario, Canada.—AVIATION, Sept., '45.

Drill Press Turret Head.....36

Improvements in re-designed drill press turret head, manufactured by Universal Engineering Co., San Diego, Calif., are described in circular. Construction of turret head is stated to be as rigid and accurate as press itself.—AVIATION, Sept., '45.

Grinding Wheels 37

Qualities and accomplishments of "Cool-Cut" grinding wheels, made by Robertson Mfg. Co., Trenton, N. J., are described in booklet, *How to Buy Production Time*.—AVIATION, Sept., '45.

Furnace Starting Coil.....38

For use in thawing out electric salt bath furnaces, new starting coil has been designed by Upton Electric Furnace Div., Detroit, and is described in pamphlet.—AVIATION, Sept., '45.

Stop Watches 39

Bulletin No. 575, from Herman H. Sticht Co., New York City, covers 1/5-sec. imported stop watches, also decimal timers which divide minute into 100 parts.—AVIATION, Sept., '45.

Jack Maintenance 40

Manual on repair and maintenance of lever and hydraulic jacks is offered by Templeton, Kenly & Co., Chicago.—AVIATION, Sept., '45.

Automatic Turret Truck.....41

Circular from Nutting Truck & Caster Co., Faribault, Minn., describes new type industrial truck in which power plant is contained in turret at front of truck.

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You get quick action on your aircraft alloy steel requirements when you call Ryerson. Our plants at Chicago, and New York are official warehouses of the ACW program. Aircraft quality steels in stock—NE 8630 and X4130 rounds and hexagons, also NE8740 and 4140 rounds—can be shipped fast to qualified users. Other steels at all eleven Ryerson plants include everything from structurals to stainless. More than 10,000 kinds, shapes and sizes in all. Write for a Ryerson Stock List—handy guide to these vast steel stocks. And call Ryerson for aircraft alloys or other steel needs.

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Clutch and transmission are automatic. —AVIATION, Sept., 45.

Thread Milling Cutters.....42

Containing tabular data on dia., number of flutes, face width, hole size, and keyway for shank and shell type milling cutters, circular from Plan-O-Mill Corp., Hazel Park, Mich., has standard cutters illustrated with drawings and photos.—AVIATION, Sept., '45.

Sandblast Equipment 43

American Foundry Equipment Co., Mishawaka, Ind., offers catalogs on line of airless "Wheelabrator" tables. — AVIATION, Sept., '45.

Milling Practice 44

Book 2 in milling practice series published by Kearney & Trecker Corp., Milwaukee, is titled *The Milling Machine and Its Attachments*, and covers knee and bed types of milling machines.—AVIATION, Sept., '45.

Visual Gages 45

Including information on various attachments which can be used with company's visual gages, new catalog from Sheffield Corp., Dayton, Ohio, describes various gage models and illustrates their applications.—AVIATION, Sept., '45.

Spline Arbor 46

Reported to solve difficulties encountered in hobbing, shaving, and grinding precision gears having splined bores, "Amtec" spline arbor, made by A. Mackmann Tool & Engineering Co., Chicago, is described in new circular.—AVIATION, Sept., '45.

Pneumatic Hand Grinders.....47

Master Tool Co., Cleveland, announces in circular new vertical grinder and die grinder, pneumatic hand tools.—AVIATION, Sept., '45.

Shop and Laboratory Equipment....48

Hoggson & Pettis Mfg. Co., New Haven, Conn., has issued new catalog covering line of marking devices, rubber tools, rubber molds, laboratory equipment, and punches.—AVIATION, Sept., '45.

Non-Marring Hammer 49

Features of non-marring hammer made by Greene, Tweed & Co., New York City, and described in Bulletin No. B-1, are adjustable split head, interchangeable faces, and balanced handle.—AVIATION, Sept., '45.

Drill Guide 50

Reported to save templates from damage, new safety drill guide made by Sheldon Tool & Mfg. Co., Chicago, features locking device. Guide is described in folder.—AVIATION, Sept., '45.

Curved-Tooth Files 51

Complete line of flexible and rigid file blades with curved teeth is shown in new catalog from American Swiss File & Tool Co., Elizabeth, N. J.—AVIATION, Sept., '45.

Rechargeable Flashlight Battery....52

Specifications and description of rechargeable flashlight batteries and chargers are contained in circular from Ideal Commutator Dresser Co., Sycamore, Ill.—AVIATION, Sept., '45.

Milling Cutters 53

Detroit Tap & Tool Co., Detroit, announces more than 60% increase in number of thread milling cutters carried in stock for thread grinding to specifications.—AVIATION, Sept., '45.

ELECTRICAL

Hermetically Sealed Instruments....54

History, advantages, and uses of glass-to-metal hermetically sealed electrical indicating instruments manufactured by Marion Electrical Instrument Co., Manchester, N. H., are given in brochure.—AVIATION, Sept., '45.

Electrical Measuring Instruments....55

Instrument Manufacturing and Service Facilities is title of booklet from Nilsson Electrical Laboratory, New York City, which contains information on custom-built instruments and apparatus, repair facilities, etc.—AVIATION, Sept., '45.

Rotary Power Equipment.....56

Bulletin No. 445 from Carter Motor Co., Chicago, describes company's genemotor, magmotor, and other rotary power equipment for mobile radio employment. Applications for aircraft are noted.—AVIATION, Sept., '45.

Transformer Boxes 57

Standard transformer cases made by Olympic Tool & Mfg. Co., New York City, and now available in quantity, are described in circular.—AVIATION, Sept., '45.

Electrical and Hydraulic Products...58

Containing description of motors, transformers, industrial brakes and controls, hydraulic and air brakes, tachographs, brake lining, and tools, catalog from Wagner Electric Corp., St. Louis, lists repair parts and service items.—AVIATION, Sept., '45.

Surplus Electronic Equipment.....59

Electronic Corp. of America, agent for RFC, offers catalog listing 507 separate electronic items for sale to trade.—AVIATION, Sept., '45.

STEELS

Manganese Steel Applications.....60

American Manganese Steel Div., American Brake Shoe Co., Chicago Heights, Ill., has issued new bulletin titled *Non-Magnetic Applications for Amsco Manganese Steel*.—AVIATION, Sept., '45.

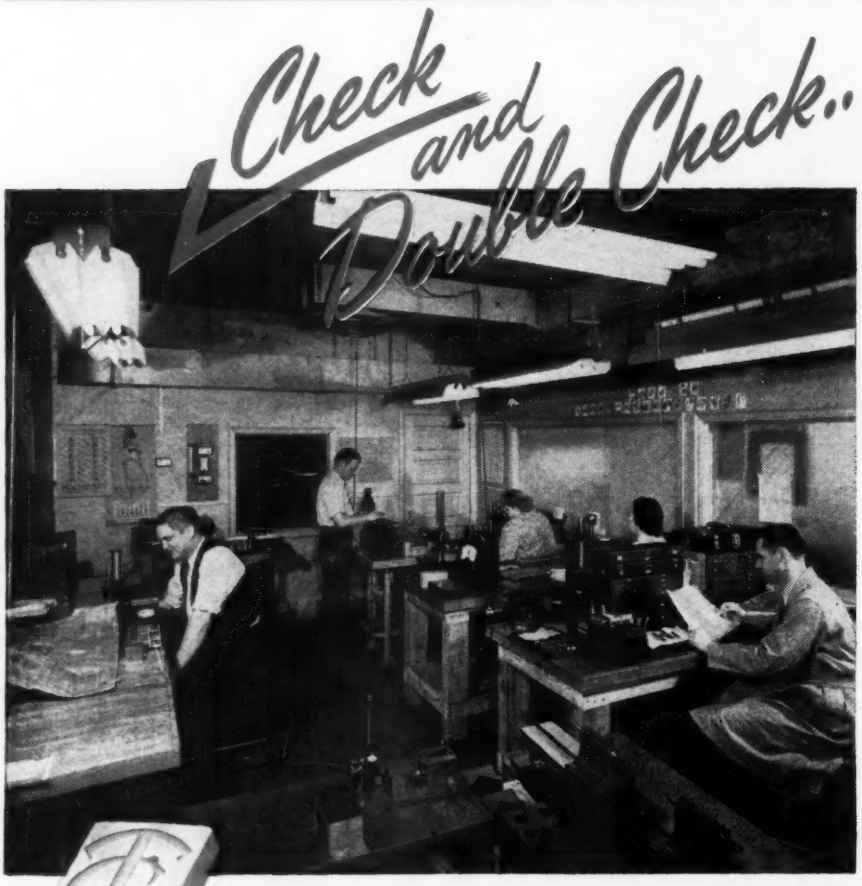
PLASTICS & SYNTHETICS

Fabric Coating 61

How "Fuzon-O," flexible vinyl resin coating developed by Stanley Chemical Co., East Berlin, Conn., is used for coating and impregnating various fabrics, is told in booklet.—AVIATION, Sept., '45.

Plasticizer Extender 62

Hercules Powder Co., Wilmington, Del.,



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TURNER BROTHERS

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announces commercial availability of menthylphenol, chemical which improves heat and light stability of ethyl cellulose plastics, film, plastic steel, adhesives, and paper coatings, and which can be used as plasticizer extender with cellulose acetate. —AVIATION, Sept., '45.

Instruction Manuals 63

Celanese Plastics Corp., New York City, announces use of Lumarith foil as printable pages in instruction manuals, affording transparency through which can be seen comprehensive details of motors, machines, and other devices illustrated.—AVIATION, Sept., '45.

PARTS & INSTRUMENTS

Flight-Hour Meter 64

Pamphlet from John W. Hobbs Corp., Springfield, Ill., gives description of new flight-hour meter for logging flying time. Device is automatically controlled by air switch mounted on inspection plate on wing.—AVIATION, Sept., '45.

MAINTENANCE & SAFETY

Roof and Wall Coating.....65

Information is available on "Liquinoleum" made by Continental Asbestos & Refining Co., New York City, waterproof coating for roofs, walls, and other surfaces, stated to have new high protective values.—AVIATION, Sept., '45.

Cement Dustproofer 66

Synthex Products Co., New York City, offers information on "Synkrete," liquid concentrate for dustproofing concrete floors.—AVIATION, Sept., '45.

One-Hand Extinguisher 67

Walter Kidde & Co., New York City, offers details of new valve placed on company's fire extinguishers to enable operation with one hand trigger control.—AVIATION, Sept., '45.

Copper-Finish Extinguishers 68

General Detroit Corp., Detroit, announces availability of copper-finish fire extinguishers of soda-acid and foam type. —AVIATION, Sept., '45.

New Chemical Extinguisher.....69

Circular from American-LaFrance-Foamite Corp., Elmira, N. Y., describes new Foamite Challenger 40-gal. engine, stated to produce higher percentage of foam.—AVIATION, Sept., '45.

NEW PRODUCTS

Latest Machinery

Duplex Seam Welder.....70

Designed to weld simultaneously two or more parallel seams on one surface, duplex seam welders developed by **Progressive Welder Co.**, Detroit, are air operated and fully automatic. Duplex head accommodates two or four welding wheels, all free rotating and driven by contact with moving work. Work is carried on table mounted on slide rails. Top of work holding fixture is formed by flat copper plate which provides lower path for current. Feed of work is adjustable from 0 to 30 in. per min. Welders are available with transformer cap. up to 500 kva. to meet requirements, and with wide choice of table sizes and travels, and wheel dia. and spacings.—AVIATION, Sept., '45.

Gear Checker 71

Designed for checking of tooth spacing on gears, Model No. 1130 precision gear checker, made by **Michigan Tool Co.**, Detroit, gages base pitch and tooth spacing along line of action on spur or helical gears, also spacing on worm gears. Max. capacity is gears up to 12 in. od., having max. shaft length of 18 in. Hand operated rack and pinion permits indicator table to be quickly adjusted to line up contact points tangent to base circle. Gage blocks

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Safety engineers don't use extinguishers. Actually, it's *the employees* who are your real fire-fighters.

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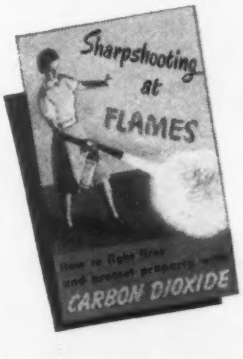
A dry, odorless gas, carbon dioxide cannot damage equipment or conduct electricity. It leaves no stain or mess . . . actually disappears when the fire is out! *Approved by Underwriters' Laboratories.*



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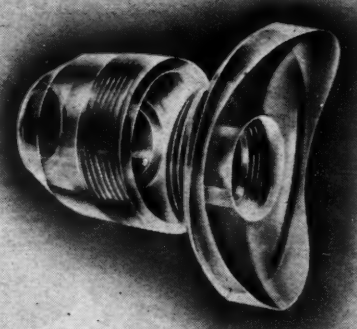

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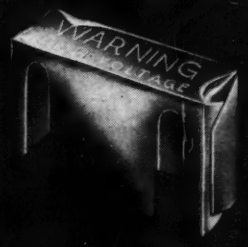
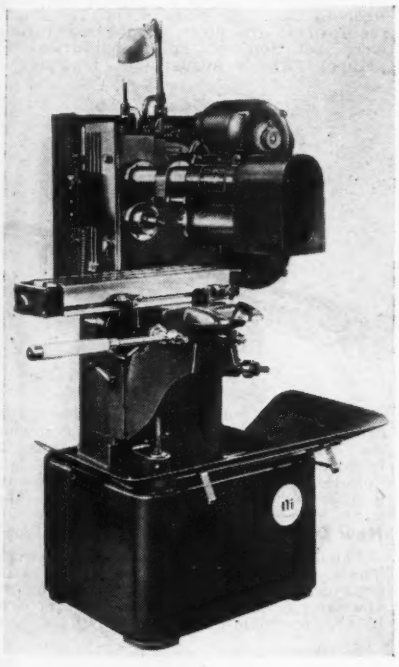


Slaco PRODUCTS

PRECISION PARTS AND PLASTICS FOR EVERY DAY USE

enable accurate adjustment of contact points. Adjustments are also provided to limit retraction of table when indexing. Over-all height is 50¼ in., height to centers is 42½ in., and floor space required is 24 in. x 33¼ in.—AVIATION, Sept., '45.



Double Spindle Millers.....72

Designed so that two cuts can be made at once, double spindle milling machines announced by **W. H. Nichols & Sons**, Waltham, Mass., are suitable for light production work. Machine illustrated has two opposed spindles with No. 40 milling machine taper. Spindles may be lined up, or may be set out of line vertically 2½ in., horizontally 2½, and in or out 1½ in. Another model can be supplied with two identical spindles, one directly over the other, with adjustment for 4½ to 7½ in.—AVIATION, Sept., '45.

Flat Broach Sharpener.....73

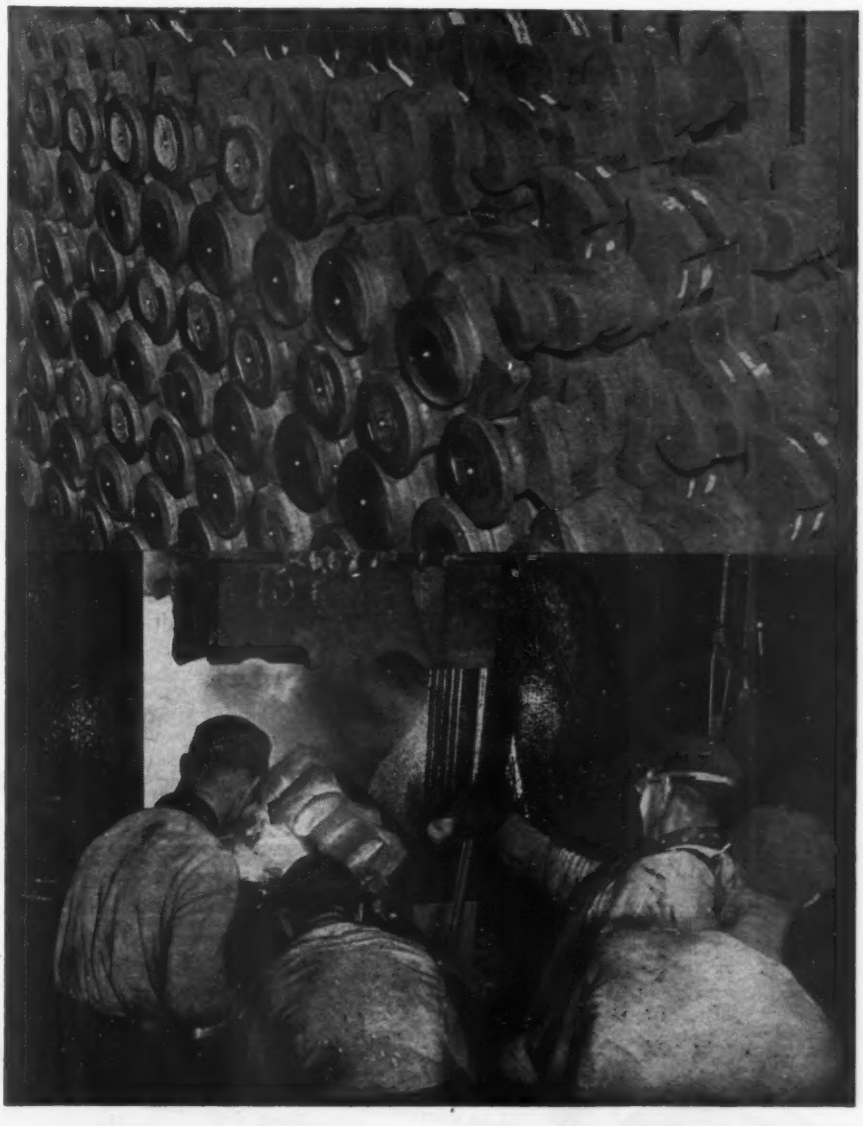
New flat broach sharpener and back-off machine, made by **Great Lakes Broach & Gage Co.**, Detroit, is reported to handle virtually all flat broaches, insets, keyways, and broach bar assemblies. Special feature is handle for table feed, graduated to .0005, to enable operator to re-step and back-off keyways without use of surface grinder.—AVIATION, Sept., '45.

Laboratory Furnace 74

Combining three different types of furnace in one casing (photo right), bench laboratory furnace made by **Surface Combustion Co.**, Toledo, Ohio, may be used as direct-fired oven unit at temp. from 300 to 2,400 deg. F. For direct heating, a muffle can be placed on hearth, and if an atmosphere is desired, diamond block can be used in muffle. A removable plug built into arch provides means of inserting pot. Dimensions are: Hearth width and length, 6 x 12 in., door width and height 5¼ x 4¼ in., and over-all dimensions, width 19½, length 21⅝, and height 29 in. Catalog number is UL-6-12.—AVIATION, Sept., '45.

Duplex Pump 75

For use in pilot plant operations and experimental pressure work, duplex high pressure pump, variable stroke, made by **Precision Scientific Co.**, Chicago, has individual cylinders permitting two types of liquids to be pumped simultaneously, or both cylinders can be piped in parallel to give increased volume. Compact design



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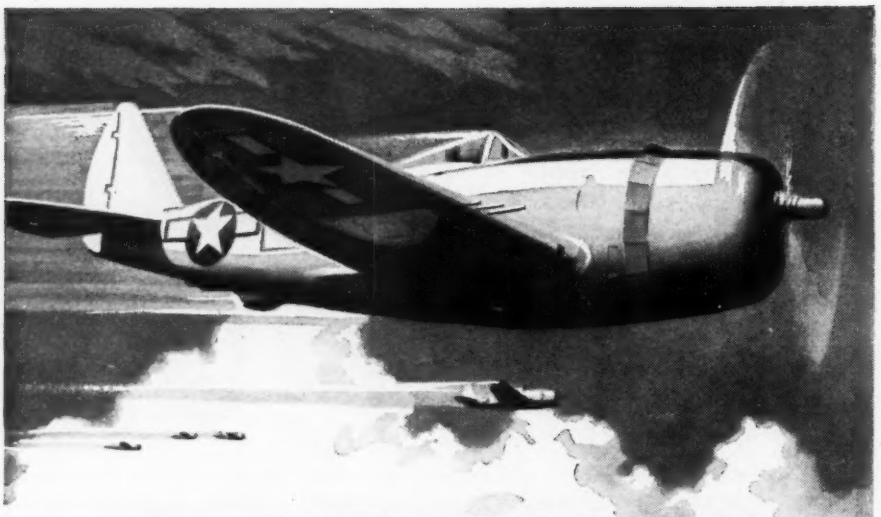
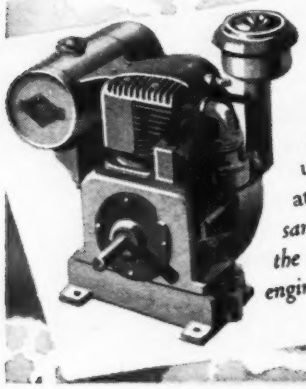


ARMY AIR FORCES
AWARD BRIGGS & STRATTON
"Approved"
QUALITY CONTROL RATING

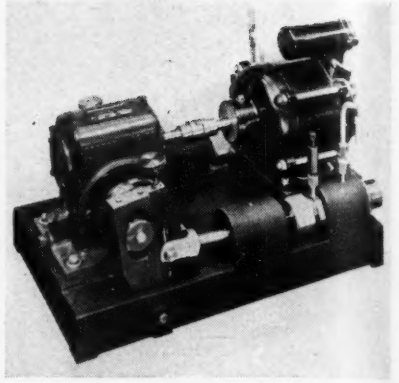
For over two years Briggs & Stratton has produced the General Electric high-tension magnetos used on the 18-cyl. Pratt & Whitney 2000 h. p. engines powering high-flying fighters, bombers and transport planes. In recognition of the high standards of inspection procedures and control in the manufacture of these magnetos, the U. S. Army Air Forces have accorded to Briggs & Stratton the "APPROVED" Quality Control Rating.

Air-Cooled Power

4 CYCLE BRIGGS & STRATTON GASOLINE ENGINES



The ultra-precision construction, close tolerances, and rigid inspections necessary in making these high-tension magnetos is far more exacting than generally used. Yet no special preparations were needed at Briggs & Stratton,— *because for many years, this same watch-like precision has been the outstanding factor in the long life and superior performance of Briggs & Stratton engines!* Briggs & Stratton Corp., Milwaukee 1, Wis., U.S.A.

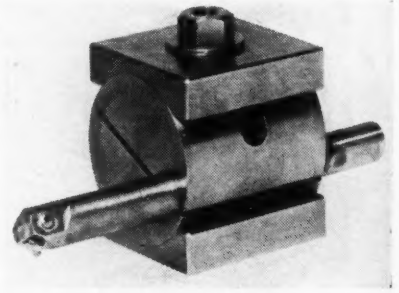


permits continuous operation and saves space. Volumetric efficiency throughout full range is over 90%, states maker.—**AVIATION, Sept., '45.**

Shop Equipment & Materials

Boring Bar Holder.....76

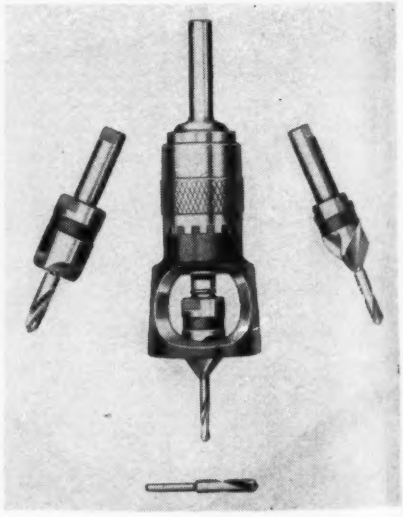
Efficiency of adjustable boring bar holder manufactured by **Welch Tool Engineering Co.**, Los Angeles, is stated to be result of up and down adjustment through easy rotation of split cylindrical bar gripper, which adjustment is made by



single center control nut. Holder fastens directly to tool post "T" slot on compound rest and can be used also for turning. Bar is always level and parallel with lathe spindle. Standard equipment includes one double end bar.—**AVIATION, Sept., '45.**

New Drill Press Tool.....77

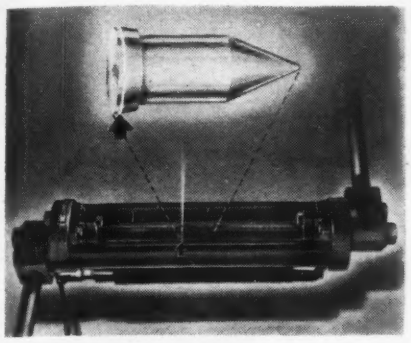
"Drilpilot," new tool made by **Aircraft Tools**, Los Angeles, is stated to enable drilling and countersinking, drilling and spotfacing, or drilling and counterboring in one operation. Body of drill is $\frac{5}{8}$ in.



long with 9/16 in. flute length, leaving 1/16 in. of solid drill body which acts as pilot after hole is drilled. Shank is .086 dia. and ⅝ in. long. Tool is available in standard rivet sizes No. 40, 30, 21, and 10.—AVIATION, Sept., '45.

Lighted Rotameter Rotor.....78

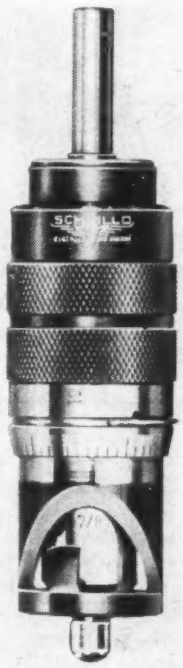
"Line-O-Light" rotor for use in reading opaque liquids with rotameter, has disk of light-transmitting material sandwiched in rotor head. Rate-of-flow is



delineated sharply in band of light on tube reference scale. Rotor can be used for virtually any application in any type tapered glass tube rotameter. Maker is Schutte & Koerting Co., Philadelphia.—AVIATION, Sept., '45.

Adjustable Stop Countersink.....79

Model 6300 is heavy duty micrometer adjustable stop countersink, with cutter capacity of ⅞ in. dia., added to line by Schrillo Aero Tool Engineering Co., Los



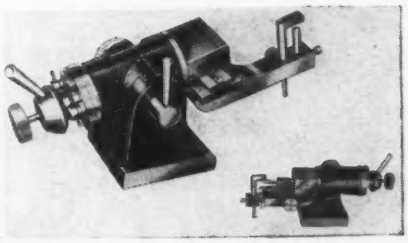
Angeles. Cutters are driven off a 7/16 in.-20 threaded shank or standard taper. Tool has full length, self-lubricating bearing. Positive lock prevents loss of adjustment. Taper shank cutter style has self-contained knockout pin. — AVIATION, Sept., '45.

Machinists' Tools 80

Available from makers stock and from distributors is new line of depth micrometers, surface gages, screw pitch gages, thickness gages, and other machinists tools manufactured by Products Engineering Co., Beverly Hills, Calif.—AVIATION, Sept., '45.

Radius Dresser 81

Enabling operator to dress—in one operation—a radius, an angle, a compound-complex angle, and an angle tangent to a radius, new angle correcting radius dresser, No. 150, has been developed by



U. S. Tool & Mfg. Co., Dearborn, Mich. When these four operations are performed, the primary diamond holder position is used, but provision has also been made for forming extremely small or large radii, in section of wheel in instance where radius has up to 180 deg. of arc. For this work, accessory equipment is used which consists of a special diamond holder mounted in the secondary position (lower right in photo above).—AVIATION, Sept., '45.

Metric Gage Blocks.....82

For manufacturers working in metric system, Continental Machines, Minneapolis, has developed new series of metric gage blocks in two grades. Inspection quality guaranteed accurate in plus or minus .0001 mm., and working quality guaranteed accurate within plus or minus .0002 mm. Set consists of 38 blocks plus 2 wear blocks (of tungsten carbide in inspection grade) and is stated capable of producing over 100,000 combinations ranging from 1.01 mm. to 100 mm. in increments of .01 mm. Special 1.005-mm. block gives special combinations for closer tolerances.—AVIATION, Sept., '45.

Gage Protection 83

Protection of gaging surfaces during shipment or storage is reported attained through use of "Jan-Seal," plastic coating developed by Jansson Gage Co., Detroit. Material is dipped on, and it is stated to be easily removed and replaced. —AVIATION, Sept., '45.

Offset Adjustable Drillhead.....84

Described as permitting drilling on closer centers, two-spindle offset-type drillhead in which one spindle is built integrally with drive shaft and the other

YOU'LL HAVE A LARGER GAGING SURFACE WITH THE NEW ROUND GAGES

by ELLSTROM

When you use the new Ellstrom round gage blocks, practically all of the gaging surface can be utilized because there are no corners, as in the case of the square blocks. For example, the gaging area of a round block is .9970 square inch while the gaging area of a square block is .7917 square inch. Gage life is thereby increased.

Chromium plating increases gage life many times over ordinary steel gage blocks.

Use of the round shape gage virtually eliminates chances of tipping, causing possible injury to the gaging surface. "Flats" prevent rolling.

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ROUND GAGES PRICES PER SET	
Set No. 2-85-W	$464.00
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Set No. 2-36-W	259.35
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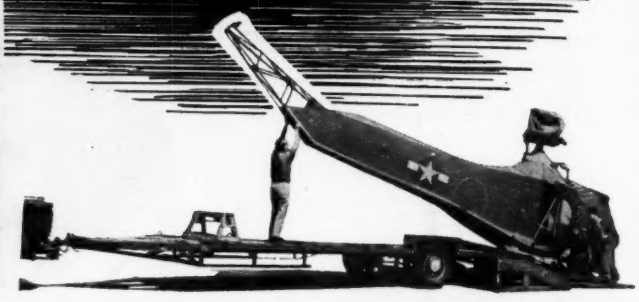

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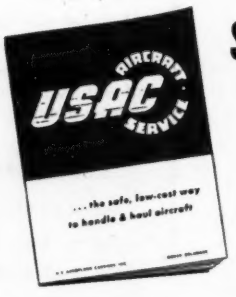
3. Fast, protective hauling of all sizes and types of planes on "tailored trailers," designed and constructed for the plane or part being shipped.
4. Plant and field surveys to determine most efficient handling methods . . . recommendations to manufacturers on production schedules to simplify and reduce cost of dismantling for shipment and handling after delivery.

In eight years of operation, USAC Aircraft Service has been proved in performance on hundreds of jobs throughout the country . . . with large and small planes . . . over all kinds of roads and terrain.



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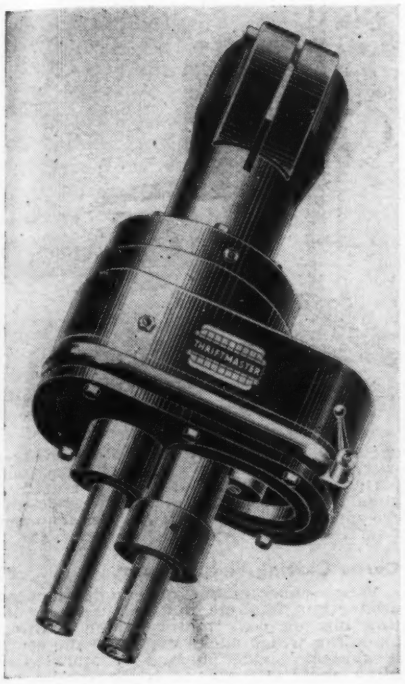


offset and adjustable, is announced by **Thriftmaster Div., Thompson Industries,** Long Island City, N. Y. Construction is full ball bearing, with all vital parts enclosed and running in grease.—**AVIATION, Sept., '45.**

Torque Tool 85

Skyway Precision Tool Co., Los Angeles, states that laboratory accuracy is obtained in precision tightening through use of "Tork Tite," a new torque tool described as of comfortable length, weight, and grip. Shaft, contained in light housing, floats in bearings. Tool is calibrated in in.-oz. and is effective up to 10 in.-lb. It may be had in models with either fixed or adjustable control.—**AVIATION, Sept., '45.**

Combination Welding Electrode....86

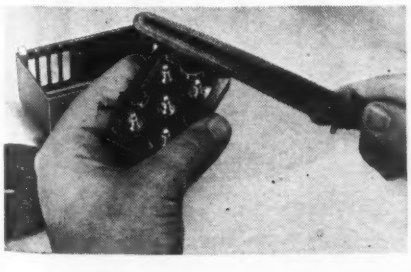
Designed to produce horizontal fillet welds with flat or slightly concave profiles and concave fillets in the flat position, as well as satisfactory deep fillet and deep groove, welding electrode No. 315 is offered by **Air Reduction, New York City.** Applications include pressure vessels and their connections, heavy machine weldments, structural assemblies, and virtually all heavy steel assemblies.—**AVIATION, Sept., '45.**

Lathe Tool Holder.....87

Consisting of a body which fits into lathe tool post, and detachable heads which hold standard high speed or carbide tipped tool bits, Type L universal tool holder made by **Lane-Wells Co.,** Los Angeles, is offered in four sizes to fit any engine lathe from 9 in. to 36 in. swing. Available are eleven different standard heads for boring, turning, facing, forming, drilling, reaming, and tapping.—**AVIATION, Sept., '45.**

Abrasive Tool 88

New abrasive tool called "Handee" finisher, manufactured by **Master Specialty Co.,** Minneapolis, is reported to be timesaver since six 12-in. abrasive strips are fastened to unit and, when worn, are readily removed one at a time by means of knob on handle. Tool is light and shaped to get at hard-to-reach edges.—**AVIATION, Sept., '45.**



BOTH EFFICIENT... AND *DEADLY ACCURATE!*

War birds of the United States Navy are writing their own glorious saga of their accomplishments. The men who fly them, and the planes themselves, must be fully efficient and deadly accurate in the perfection of their workmanship.

Those of us who are privileged to manufacture a portion of the supplies needed by both the Navy and Army air men realize that we, too, must be efficient and accurate in the goods we produce. An "Arresting Hook" must work. It cannot fail. It suffers tremendous strain whenever a war bird alights in its "flat top" nest.

Arresting Hooks for Naval aircraft are one of several hundred highly stressed and precision parts we forge, weld and assemble for the war program.

The skill, craftsmanship and facilities necessary to produce these items can also serve you. Just write to us, today.

BUY UNITED STATES WAR BONDS AND STAMPS

★ **AIRCRAFT MECHANICS** INC.

COLORADO SPRINGS, COLORADO

DESIGNERS • • • ENGINEERS • • • MANUFACTURERS

Degreaser 89

Models "Chief" and "Comet" degreasers are new numbers in line made by **Circo Products Co.**, Cleveland. Equipped with twin tanks, one for solvent vapor cleaning, the other a solvent storage tank for dipping, soaking, or spraying, units vapor-clean automatically. Vapor tank is equipped with electrical heaters controlled by thermostatic switches. Units are equipped with solenoid valve, strainer and liquid level control.—**AVIATION, Sept., '45.**

Matched Gear Puller.....90

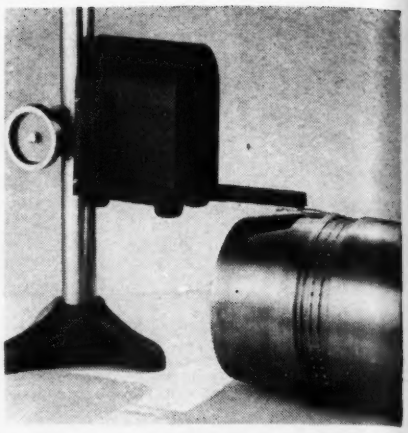
Snap-On Tools Corp., Kenosha, Wis., announces series of matched gear pullers, including three sizes of standard pullers with max. jaw cap. of 4½, 8½, and 14 in. Small and medium sizes are also available in slide-hammer design, or they can be furnished with all parts necessary for use as either standard or booster hammer pullers. Yoke and jaw construction is identical on all models, with spring controlled jaw lock. Long jaws permit use of puller where shaft extends beyond gear or other part. Hexagon end on standard model pressure screws can be turned with standard wrenches.—**AVIATION, Sept., '45.**

Tube-Flaring Tool 91

Described as giving the right taper without flattening or distorting aircraft tubing, new No. 835 tube-flaring tool and cutter, made by **Owatonna Tool Co.**, Owatonna, Minn., is furnished with seven dies from 3/16 to ⅝ in., and with built-in cutter. Reamer folds back against tool when not in use. Tool need not be clamped in vise.—**AVIATION, Sept., '45.**

Measuring Head 92

New rough finish measuring head for checking rougher surface finishes and waviness in metals, glass, plastics, and plated and painted materials, is stated to gage irregularities from 100 to 3,000 micro-inches. Maker is **Brush Development Co.**, Cleveland.—**AVIATION, Sept., '45.**



Curbs Cutting-Fluids Vapor.....93

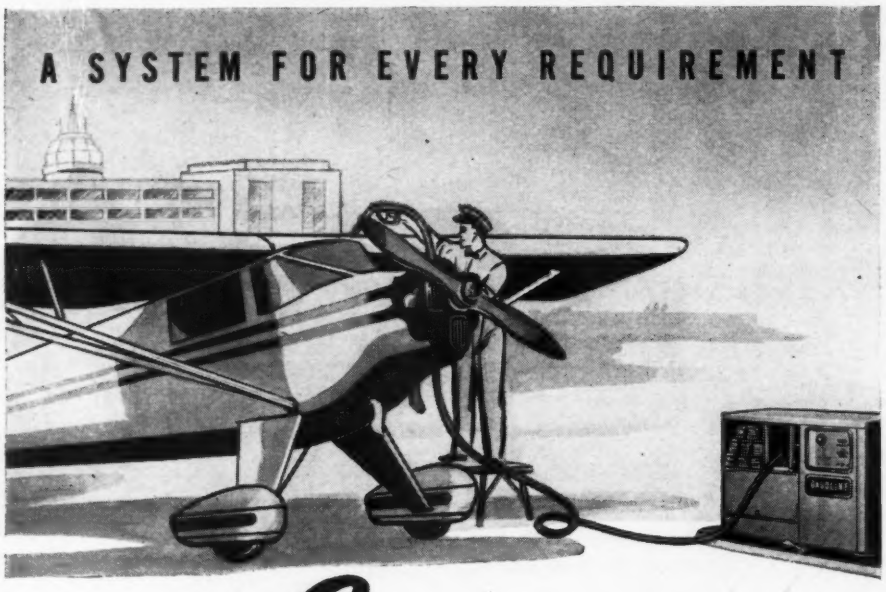
Vapor collector for use on high speed production machine tools employing cutting oils employs motor driven multiple blade fan which sucks up vapor and sends it against inside surface of spun glass filter material, where it is condensed, collected, and returned to reservoir. Maker is **Aget-Detroit Co.**, Ann Arbor, Mich.—**AVIATION, Sept., '45.**

Lathe File 94

Kennametal Co., Latrobe, Pa., reports its new lathe file will cut steels that other files will not touch, at much higher speeds than normal, and with longer life. Blanks have brazed-on nuts and are attached to lightweight handle by screws. Fine blanks (30 teeth to in.) and coarse (20 teeth to in.) are available.—**AVIATION, Sept., '45.**

Tool Size Identification.....95

Larrimore Sales Co., St. Louis, has devised system color identification for closely related sizes of tools, and is now merchandising a color chart for use in connection with this system.—**AVIATION, Sept., '45.**



WAYNE *Computing*
AIRCRAFT REFUELERS

SELLS OIL, TOO!

HERE'S a complete airport "service station" in one compact, streamlined unit. It offers new operating advantages and conveniences for the fueling of planes. The time-tested units of the famous Wayne Computing Dispensing Pump have now been adapted to the refueling of aircraft, including a self-retrieving hose reel, with many refinements developed by Wayne engineers. Easy to install... nothing else to buy. In the same sturdy cabinet, storage space is provided for three cases of quart cans of oil or the space may be used for tools, etc. Built low enough so that almost any airplane wing clears it. Available soon. Write today for bulletin and prices.

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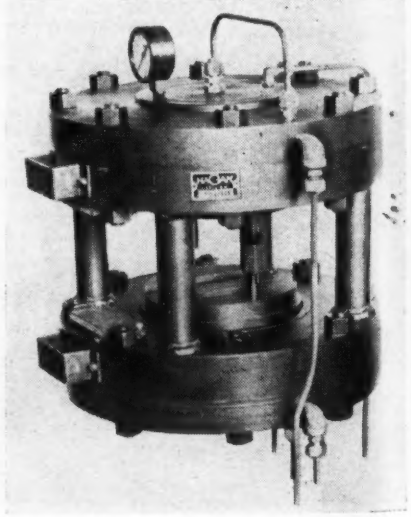
LONDON TORONTO RIO DE JANEIRO ADELAIDE

WAYNE *Airplane* REFUELING SYSTEMS

Aircraft Parts & Field Units

Measuring Thrust 96

Used to determine and record thrust and torque of conventional and jet aircraft engines, "Thurstorq" is instrument '45.



ELECTRIFYING the Road to Tokyo

Curtiss Electric Propellers now add to the demonstrated effectiveness of the Boeing B-29 Superfortress:

Greater striking force—made possible by propeller weight reduction.

Shortened landing runs—through aerodynamic braking.

Automatically synchronized propeller speeds.

The unmatched durability of hollow steel blades.

The additional safety of electrical propeller control, unaffected by temperature and altitude and with minimum vulnerability to combat damage.

These new advantages for the Superfortresses on the road to Tokyo mean new destruction for the enemy and increased security for B-29 crews.

CURTISS

Electric Propellers

DIVISION OF **CURTISS WRIGHT** FIRST IN FLIGHT

"TAIL-FIRST" PLANES ARE

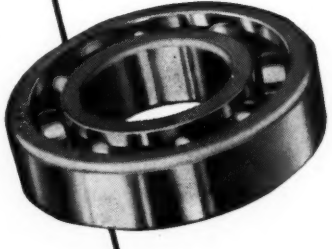
ALSO SKF-EQUIPPED

BUILT BY CURTISS-WRIGHT CORP.

Men who do things that have never been done before invariably include SKF Bearings in their experiments. And so it was in designing this Curtiss Ascender with its power plant and wing surfaces mounted to the rear of the pilot while elevator controls are in the extreme nose—effecting the appearance of flying backward. Again SKF puts the right bearing in the right place for a significant contribution to aircraft design.

5863

SKF INDUSTRIES, INC., PHILA. 34, PA.



SKF

BALL AND ROLLER BEARINGS

made by **Hagan Corp.**, Pittsburgh, to measure and weigh with air. Heart of unit is diaphragm which forms one face of airtight chamber into which compressed air is admitted through poppet type pilot valve. Force to be measured is applied to outside of diaphragm and is opposed by internal pressure. As force increases, pilot valve is opened and admits more air to balance increased force; and vice versa. Thus air pressure within chamber directly measures externally applied force. Remote reading is possible on any number of manometers, pressure gages, or recording devices.—**AVIATION, Sept., '45.**

Stamped Metal Lock Nut.....97

Mechanical Device Co., Bridgeport, Conn., announces new patented sheet

metal lock nut, available as separate pieces in many types and sizes, and also as stamped-in part of metal product.—**AVIATION, Sept., '45.**

Parking Brake Valve.....98

Aircraft equipped with hydraulic brakes may now be provided with parking brakes through use of new Model 4200 parking valve developed by **Scott Aviation Corp.**, Lancaster, N. Y. Valve is installed in hydraulic line between each master cylinder and brake assembly.—**AVIATION, Sept., '45.**

Fuel Oil Concentrate.....99

Reported to prevent corroding and sticking of injector nozzles, and to provide top cylinder lubrication, "Gibraltar" Diesel fuel oil concentrate is now offered by **Hood Refining Co.**, Greensburg, Pa. Concentrate is added at rate of 4 oz. to each 10 gal. of fuel oil.—**AVIATION, Sept., '45.**

Snow Tractor 100

Supplied to AAF but having peacetime commercial applications, "Snow Cruisers," made by **Iron Fireman Mfg. Co.**, Portland, Ore., is lightweight wide-treaded tractor capable of transporting as much as 4,000 lb. in deep snow and up grades of 35 deg.

Built of four component parts—two tracks, power section, and cab—it can be readily dismounted for transportation by plane. Removable cab permits driving tractor directly into fuselage of large transport. Cab accommodates three men and operator.—**AVIATION, Sept., '45.**

Coated Upholstery Fabric.....101

Developed for use in aircraft and for other uses, "Cavalon" plastic coated fabric, made by **E. I. DuPont de Nemours, Coated Fabric Div.**, Fairfield, Conn., consists of flame-proofed cotton cloth base with flexible fire-resistant surface coating of synthetic resin. It will be available in range of colors, grains, and finishes.—**AVIATION, Sept., '45.**

Electrical Appliances

Portable Current Transformer.....102

Suitable for laboratory-standard work or for testing in field, Types JP-2, -3, and -4 portable current transformers, made by **General Electric Co.**, Schenectady, are described as highly accurate. They may be obtained as multi-range units, with Type -2 also available as single-range. JP-2 is not supplied with primary winding, but hole in core enables passing of cable or conductor. There is, however, a tapped secondary winding, and terminals on top of case are all secondary. JP-3 is designed with combination of wound-primary and through-primary construction. Ratings of 100 amp. and below are obtained by wound primary with terminals on top. By passing conductor through transformer window once, 1,000- and 1,200-amp. ratings may be obtained. Additional ratings are gained in both units by passing conductor through window two or more times. JP-2 and -3 are insulated for use on circuits not exceeding 2,500v. but can be used over cables on higher voltage circuits if cable is insulated for circuit voltage. JP-4 is designed for highest grade application. It is of wound-primary construction with taps in primary coil for different ratios. Each primary coil is protected with removable fuse, and secondary terminals are provided with short circuiting switch and "Thyrite" protector.—**AVIATION, Sept., '45.**

Gas-Filled Rectifier Tube.....103

Chatham Electronics, Newark, N. J., announces Type 3B28 inert-gas-filled rectifier tube with following characteristics: Peak inverse voltage 10,000v., peak plate current 1.0 amp., av. plate current .250 amp., and tube voltage drop 10v. Filament current is 5.0 amp. at 2.5v. At 500 cyc. or less, peak inverse voltage rating is 6,500v. at 2 amp. peak plate current, .5 amp. av. plate current. Base is medium four-pin bayonet type, and top cap is medium.—**AVIATION, Sept., '45.**

Aluminum Cable Connector.....104

In manufacture of "Hydent" connectors for small aluminum cables, zinc is plated on oxide-free aluminum. Barrel of each connector is filled with petroleum jelly in which zinc dust is suspended and forced between individual strands when

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4. Routine gage inspections can be greatly reduced.
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Special Carboloy Gages and tools made to your specifications.
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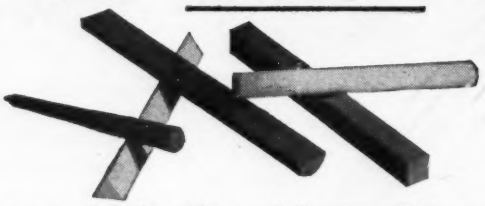
ACCURACY PERFEX OUR CREED

Easier with OILSTONE FILES

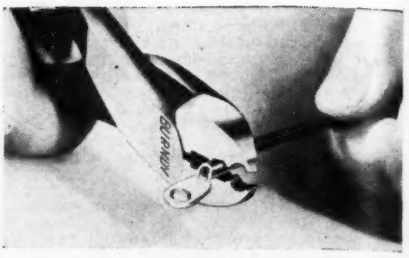


OILSTONE files are abrasive files and they're *all* file, not just rows of cut teeth. But their main utility in production and rework finishing of machined parts lies in their ability to perform light, offhand stock removal operations after machining, but within the original tolerance limits.

Whether on revolving work or bench pieces, the hard, sharp abrasive crystals in oilstone files, shaped for conformity to work contours, quickly but delicately remove burrs and sharp edges, refine radii and bevels, or eliminate the binding of mated parts. India (Aluminum Oxide, oil filled) and Hard Arkansas (natural abrasive) Files offer Industry a complete size and shape range of over a hundred items with a finish spread from coarse, medium and fine India to the surgical fineness of Hard Arkansas.

Ask your Behr-Manning Field Engineer or your friendly distributor salesman about Norton Abrasive Oilstone Files. New color chart, "Industry's Oilstones," available on request.

BEHR-MANNING · TROY, N.Y.
(DIVISION OF NORTON COMPANY)
ALSO RELIABLE COATED ABRASIVES SINCE 1872



cable end is inserted into barrel. When connector is indented with tool, zinc particles break through oxide film on each strand. Connectors are available for all aircraft electrical conductor sizes. Maker is **Burndy Engineering Co.**, New York City.—**AVIATION, Sept., '45.**

Solderless Connector Strips.....105

Incorporating company's knife-switch disconnect terminal design, new connector strips made by **Aircraft-Marine Products**, Harrisburg, Pa., has permanent disconnect member of splice with extended tongue which fits into connector strip. This member terminates in a knife-switch stamping to which any terminal of knife-switch design may be readily connected or disconnected. Two types are available: (1) Single-width strip adapted to use with pre-insulated splicing terminal requiring no insulation sleeving, with knife-switch part of permanent member extending outside strip and connection and disconnection made without removing cover of assembly; and (2) double-width strip in which disconnect ends are enclosed, locked and insulated by cover, halves of which are independent. — **AVIATION, Sept., '45.**

Non-Linear Potentiometer 106

Reported to have specially high degree of accuracy, through new design, non-linear wire-wound potentiometer manufactured by **Fairchild Camera & Instrument Co., New York City,** is stated to have reached, for certain curves, tolerances of ½% or better. Features described: High flexibility for reproducing any desired curve within certain limits, small size, long life and sustained accuracy, ability to replace more costly alternative circuits and components. One size, 1⅞ in. o.d., is available, with other sizes planned. Present model can be used singly or stacked.—**AVIATION, Sept., '45.**

Pressure Transmitters 107

Operating from simple batteries direct to indicating means, new "Model PV" pressure transmitters made by **Statham Laboratories,** Los Angeles, are available in ranges from plus-minus ½ to plus-minus 50 psi. for use as primary elements in indicating and recording dynamic and static pressures of air or liquids. In most applications, no amplification is required. Sensitive element employs the unbonded strain sensitive filament technique developed by maker. Bridge is connected and permanently balanced inside instrument. Linearity, accuracy, and permanence of calibration are stated to be dependable within 2%. Zero is independent of ambient temperatures, and calibration factor is stated to be altered less than 4% by reducing ambient temperature to —65 deg. F. Weight is 8 oz. Dimensions are 1¼ x 1¼ x 2½ in.—**AVIATION, Sept., '45.**

Electrical Insulating Board.....108

Rogers Corp., Manchester, Conn., announces "Durok," 100% non-cotton cellulose electrical insulating board. Dielectric strength, ranging from 400 to 600 v. per mil., is reported. Methanol and naphtha extractables are stated to be .02 to .12%, and .02 to .08%, respectively. Chemical treatment or sizing are absent. Stock sheet sizes are 36 x 48 in. and 36 x 24 in. Thicknesses available are .015, .020, .025, and .030 in. Material is also fabricated into motor slot cells and other insulators and structural pieces.—**AVIATION, Sept., '45.**

Timing Contactor 109

Used for testing electrically operated mechanisms, such as solenoids, relays, and other devices, particularly where breakdown or life tests are desired, new timing contactor made by **B/W Controller Corp.**, Birmingham, Mich., consists of synchronous motor, available in various speeds, and two micro switches operated by cam

ANNOUNCEMENTS—

of new machinery, shop equipment and materials, electrical appliances, and aircraft parts and field units are invited.

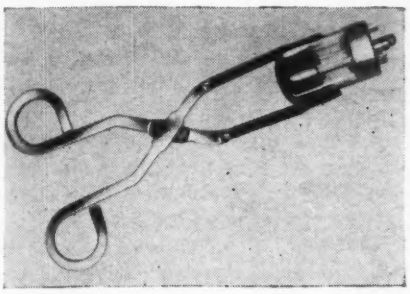
In writing, emphasis upon specific aviation applications of newly-marketed items is desirable. Also, whenever possible, glossy-print photos should be enclosed. Please do not send electros. Address—

New Products Editor, AVIATION 330 W. 42d St., New York City 18

disk fastened to motor shaft. It is stated to require no attention and to enable continuous operation. Unit is portable and has no tubes.—**AVIATION, Sept., '45.**

Radio Tube Extractors 110

New radio tube extractor made by **BMP Co.**, Boonton, N. J., is designed for



inserting and extracting delicate miniature and straight-side glass tubes. Gripping surface is rubber covered.—**AVIATION, Sept., '45.**

Banks Opening Books

(*Continued from page* 187)

heavy planes there should also be an all-risk policy on which any deductible feature does not exceed 10% of the policy's face amount.

Aviation underwriters also have available for banks a blanket master policy covering the bank against the possibility that the borrower may violate some policy condition and thus forfeit the policy benefits. Such policies usually apply to lightplanes only.

In direct bank loans to individual plane buyers, commercial operators, group purchasers, or flying clubs, the A.B.A. stresses the point that the borrower's ability to pay the cost of operation, maintenance, hangar expense, and insurance is of major importance in considering the loan application. As stated earlier, this particular credit factor may approximate, on an annual basis, 40% of the original selling price of a lightplane. Other factors to be considered are the borrower's moral character, stability of his income and employment, and previous credit experience.

Loans under present government credit regulations, the A.B.A. points out, should not exceed 1 yr. It was common banking practice before Regulation W was issued to make loans

Blue Streak
IN PARTS CLEANING
Circo Chief DEGREASER
PROGRESS is the outgrowth of experiment and enterprise and the most progressive step made in the last twenty-five years in parts cleaning is the new modern Circo "Chief" degreaser.
You will find in the Circo "Chief" degreaser, record breaking speed in parts cleaning and drying never before attained and with this speed absolute cleanliness.
Man hours, consumed in old fashioned "bucket and brush" cleaning methods cannot begin to compete with the Circo "Chief" degreaser because the "Chief" will vapor clean and dry in a few minutes time, more work than a mechanic can possibly turn out in hours and do a much better job of cleaning. Circo "Chief" will actually hot vapor clean and dry dirty, greasy parts in three minutes without encroaching on the mechanic's time other than seconds used in putting parts in tank.
Consider these facts, the Circo "Chief" saves cleaning time, many hours—saves mechanic's time, which can also run into many hours—saves costly materials—eliminates the aftermath of mopping up the mess and does a far superior job of cleaning than is possible with any other method. Circo "Chief" cleans parts five different ways: vapor cleaning (automatic), drying (automatic), spraying (automatic), dipping and soaking.
You can't afford to be without a Circo "Chief" degreaser, not if you employ two or more mechanics . . . Send in for free literature.
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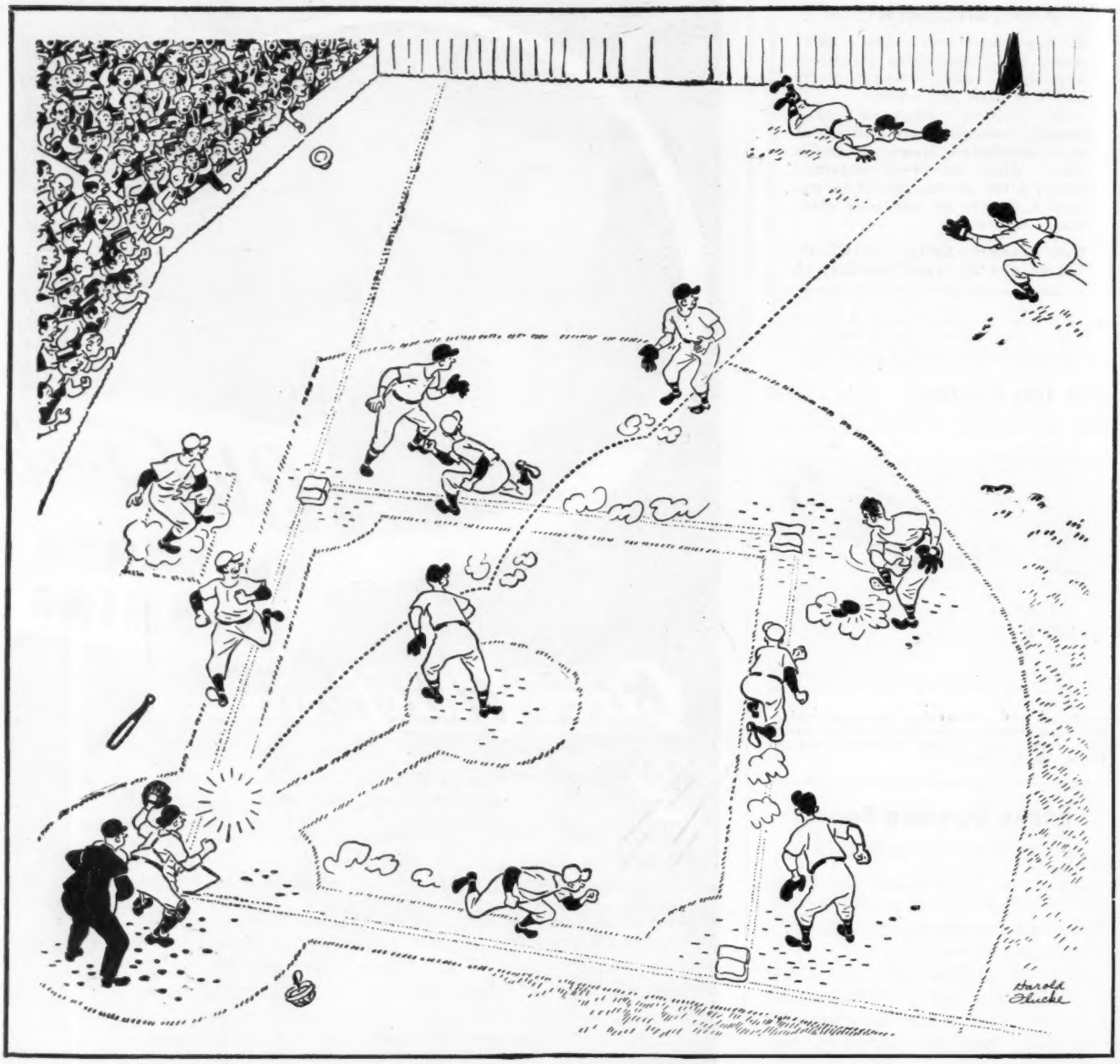
SPRAYING
SOAKING
VAPOR CLEANING
DIPPING
HOT VAPOR DRYING
5 CLEANING METHODS IN ONE UNIT



Nothing Rolls Like a Ball . . .

. . . and Pipsqueak O'Shay has just applied that principle in a manner which wins ball games!

That same fundamental fact—"Nothing Rolls Like a Ball"—is the difference between *ball* bearings and any other type bearing. Throughout war and industry, New Departure Ball Bearings are proving their unique fitness for our new world of higher speeds and heavier loads.

For the simple device of carrying the loads on a circle of tough steel *balls*, rolling freely in precision-ground raceways, has been the answer to many a 64 Million Dollar Question.

We believe no other bearing has as many—and varied—advantages as the *ball* bearing. Particularly the ball bearing backed by the technical skill and the wide experience of New Departure. 3377

There is more for you in a New Departure ball bearing than steel and precision. Advanced engineering and a desire to serve are tangible plus values.

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BALL BEARINGS

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for 18 mo. on new or used planes. Since the history of such loans was uniformly good, it seems probable that 18-mo. loans will become common again after Regulation W is revoked.

The prewar practice was to charge $6 per $100 on new planes. The A.B.A. $100 on used planes. The A.B.A. recommends that financing rates should parallel those used in financing autos. The amount advanced, excluding the finance charge but including insurance, should not exceed 66⅔% of the appraised value of used planes.

When loans are made to flying clubs, the bank probably will insist that all members sign the note, both individually and collectively. Banks are cautioned by the A.B.A. to exercise care in granting club loans because of the occasional difficulty of members within such groups to get along amicably. Moreover, some aviation underwriters do not insure the aircraft owned by such clubs.

In financing retail sales through dealers, banks are advised to make the same financing charge as is recommended for individual loans. Dealers can expect the banks generally to follow closely existing plans for automobile dealer financing. Loan maturities probably will not exceed 66⅔% for either a new plane or the appraised value of a used plane. In the case of used planes there are problems of valuation and of the "loading factor" which some insurance companies take into account when figuring the cost of insurance.

This loading factor is an additional insurance premium charged on the difference between the present used plane selling price and its original delivered price. Some insurance concerns base their insurance rates on the loading factor method, others on appraised value. Aircraft price guides, similar to those for autos, are available to aid in establishing loan values on used planes.

When the banks finance a dealer's floor planning, the planes against which advances are made may be held as the property of the bank stored on the dealer's showroom floor. They are to be used for display only and probably should not be demonstrated without the bank's permission.

Where the dealer does not pay cash at the factory for the planes he buys, the factory will sell the bank the dealer's mortgage (assigned to the bank by the factory) or use a bill of sale. The A.B.A. points out that dealers may make arrangements with the factory to draw a sight draft on the bank that is extending the floor credit.

This procedure requires the prior confirmation to the manufacturer by the bank approving the credit. If

KEEP TURNING AND EARNING

DARNELL CASTERS

these low-cost floor protection products have been made to give you a long life of efficient, trouble-free service.

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HARRIS MOUNTS
Cushion - Cradle - and Protect . . . . . delicate INSTRUMENTS
USED EXTENSIVELY ON PLANES • RADIOS • ELECTRONICS
Delicate instruments such as those used on planes, radios and electronics are subject to excessive shock, jolts and vibration in their line of every day duty and need protection in order to operate efficiently for any length of time. • Harris Mounts are widely used because they cradle, cushion and protect these instruments by absorbing up to 90 percent of this jolting, jarring and excessive vibration. Harris Mounts are extremely light in weight yet are rugged and will render unusually long and efficient service. • They are made in accordance with the Army-Navy standards to suit any combination of weight, frequency, deflection or operating condition and come in both cup and plate form. • If you have a problem, just drop us a line, our engineers, specialists in the field of engineered vibration control will gladly work with your engineers. Our free bulletin series 1022 on Harris Mounts will be gladly mailed upon request. Send for it today.
HARRIS PRODUCTS CO.
CLEVELAND 4, OHIO • U. S. A.

approved, the manufacturer then sends all necessary papers in a sight draft envelope to the bank. Again, the floor financing of planes should be handled like that of motor cars, except that a copy of the mortgage must be filed with the CAB.

The A.B.A. recommends that terms should not exceed 150 days, with reduction of 10% of the advance in 90 days, 10% at the end of 120 days, and payment of the balance after 150 days. It is also recommended that banks advance 85 to 90% of the factory cost plus delivery costs. If the dealer has paid cash to the factory, then the bank can make a direct loan to the dealer for 85 to 90% of the dealer cost.

Generally, the note and mortgage is due in 90 days or on demand. Interest at 6% on net balances has been the usual charge made by banks that have had experience in this type of financing. Floor plan loans on used planes are likely to be limited to 50% of the dealer's cost of the used plane.

In the matter of student or advanced training courses, the A.B.A. counsels bankers to have the schools accumulate their student's notes and use them as collaterial on a bank loan to the school. Here it is recommended that the banks advance 50% on the collateral collected.

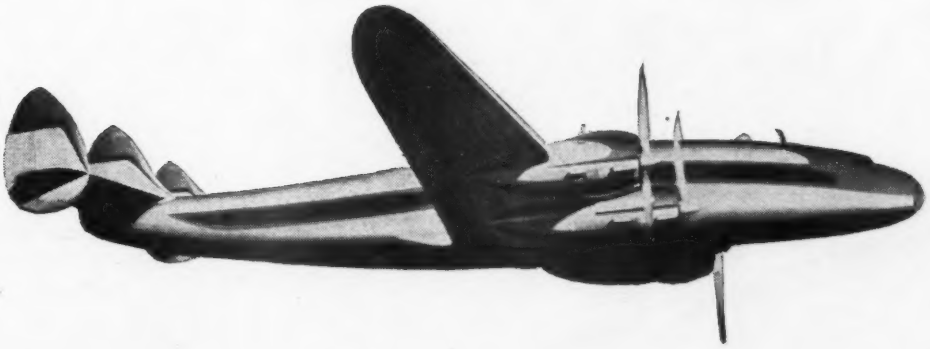
Joseph T. Geuting Jr., of the Aircraft Industries Assn., believes that the banker has a leading role and responsibility in his community to further the sane development of landing facilities and airparks. Some localities with ambitious ideas, he points out, are "going overboard" with costly plans for facilities that will not be needed. They should have the guidance of local bankers to curb their enthusiasms. As with everything else, the size of landing fields should conform with the communities requirements. Erected on such a basis, they would be public utilities that would repay the investment, both directly and indirectly.

Other towns, Mr. Geuting feels, are holding back, not recognizing aviation's significance for the future of their community. A banker is traditionally slow to rush into an unknown field. But aviation is pushing ahead so rapidly these days that only the informed, airminded banker will be able to keep abreast of the trends in the new air age.

Parapacks

(*Continued from page* 113)

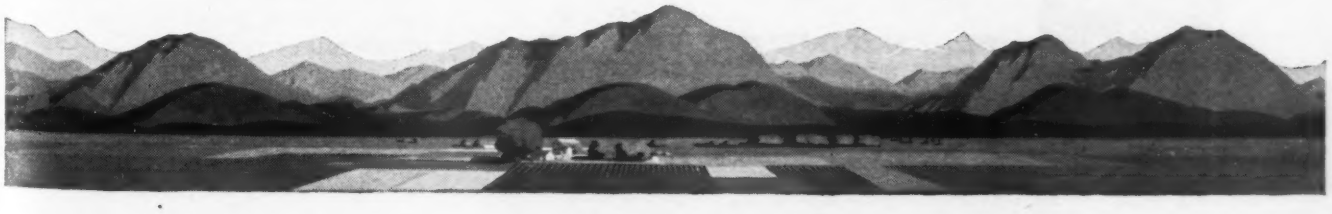
front line position, rocket strikes against enemy installations, and anti-



THERE'S A NEW STANDARD IN AIR TRANSPORTATION!

Lockheed Constellation

Lockheed Aircraft Corporation, Burbank, California — *Years ahead in the science of flight*



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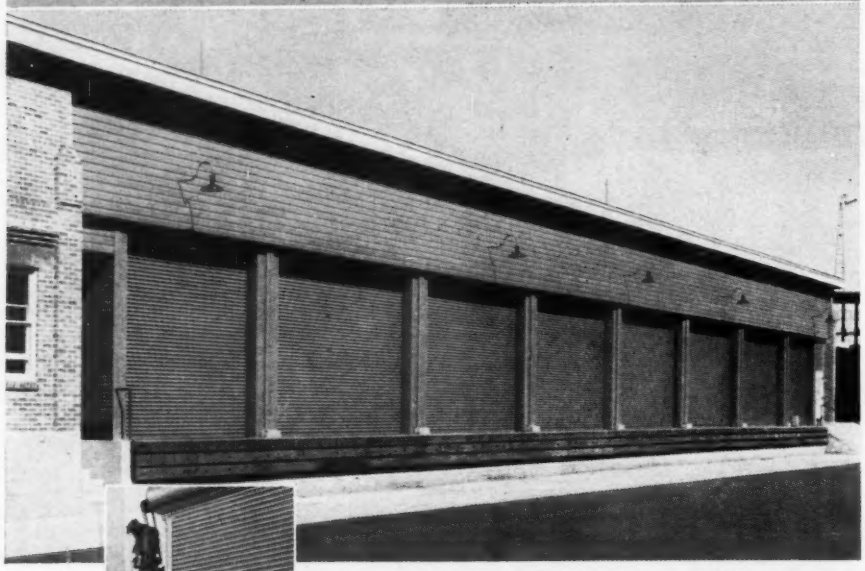

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They dropped various things, from 75-mm. artillery shells, to water, rations, medical supplies, and small caliber ammunition. On Okinawa they even dropped doughnuts to frontline troops—as many as 1,000 a day when the load of more urgently needed items wasn't too heavy.

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"We just rolled it out the door of a C-47," explains the lieutenant "and it sailed down under its 'chute just as easy as a baby being rocked in a cradle."

Atomic Frame — Or Else

(*Continued from page* 107)

during the last two years, plenty of them would not have cared to remain in those big cities, knowing the Germans were working on such a weapon. Formerly, our man-in-the-street probably rationalized that "there isn't a chance in a thousand of any bomb hitting me." But with the A-bomb there's hardly a chance in a thousand that he'd be missed. Five years from now, when other nations can be expected to have caught on to this atom business, we can expect this fear to be heightened.

We say five years because competent authority figures other leading nations could learn the "how" of the atom bomb in that time. And knowing now that scientists *can* do it makes it all the easier. They might not need $2,000,000,000 and 125,000 men, either. Once fought wholly on fields at the front, war grew to include battles between opposing scientists and laboratories. Today, peace is only "peace"—for the battle of the scientists and researchers must go on without reference to V-days.

Able atom scientists may be named in a good half a dozen countries, and Japan itself had at least one who was cited for a comprehensive paper on fission. Hitler may not have initially

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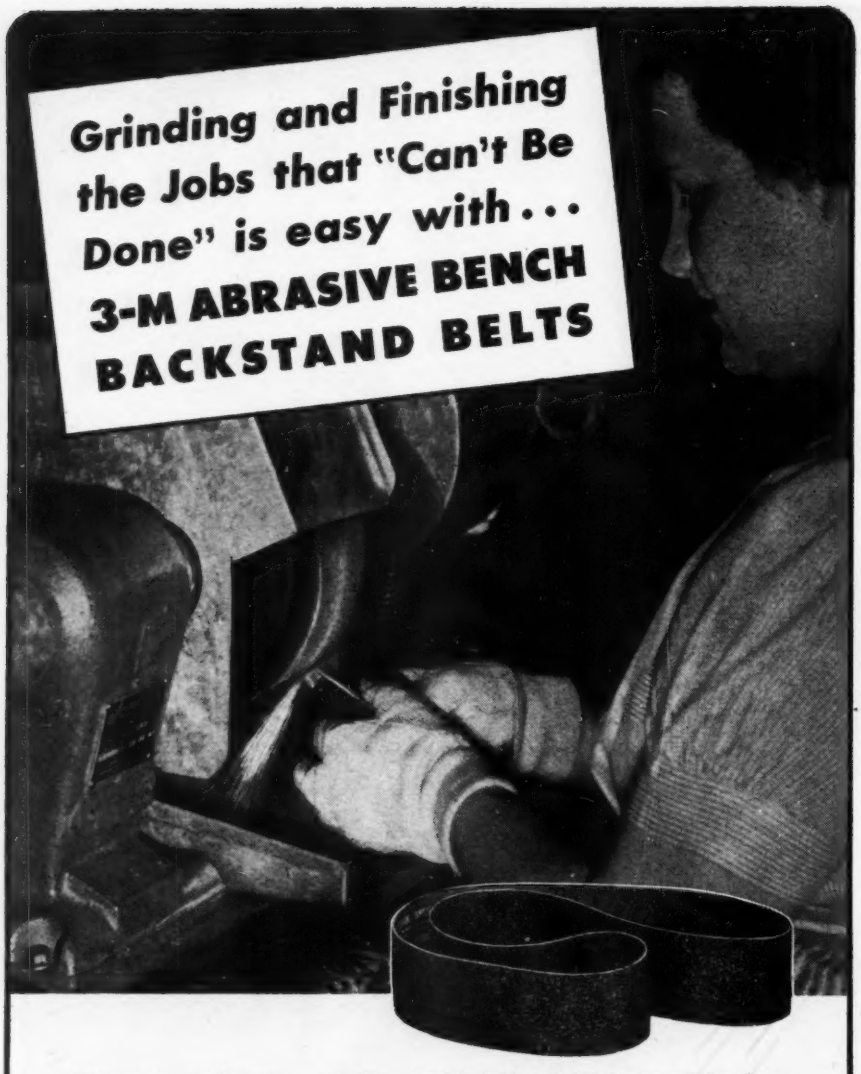

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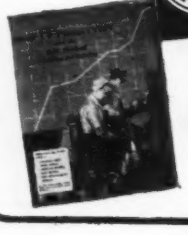

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wished to trust the Nipponese with the facts that German savants had dug up, yet it remains that, following VE-Day, a U-boat was intercepted carrying uranium to Japan. German ideas of repeating a try for world domination may be encouraged by the knowledge that atom power can immediately put a nation up front. As for the Japanese, their war-end statements literally threaten that they will attempt all means to come back with such power. "Our defeat," they blandly remark, "is only temporary." And just before the war ended, one Jap radio said: "Since the Anglo-United States have resorted to it (the atom bomb), Japan is fully justified in retaliating."

As for raw materials, there are in the world several deposits of pitchblende, and of the less-good carnotite, from which uranium may be derived. Some of these sources are at the command of the present possessor nations. Undoubtedly, other sources will be discovered. Nations in the past have fought over coal and oil deposits, and we may now see a scramble to command uranium. The day when atomic fission will give all of us cheap and abundant power—thus making raw material conflicts unnecessary — is surely distant.

Now to a more careful consideration of the impact to the military of this missile which leaves hardly one stone atop another: Fundamentally, the bomb, in both its present form and in its most logical continuations, is an air weapon. It requires broad changes in theories and means of air power as well as of army and navy power. Prior to its use, our naval air power could command the waters of the earth, while our Army air power demonstrated it could eventually wear a land enemy down to defeat. For we had more combat planes than the rest of the world. But given A-bombs, only a few hundred planes would be needed to strike with the full weight of all the bombs dropped on Europe during the entire western war.

Thus is strategic air war modified—with less planes, and with less bombs. Which is unique since, roughly speaking, the old concept was to get as many of every military device as possible. Bulk has lost its former meaning. However, the tactical air arm is less affected at present, still seemingly being needed to channelize the attack and consolidate the conquest. In short, military manpower must still occupy, organize, and command. No atomic field weapon is yet in hand. Hence, precision bombing and the operations of reconnaissance, liaison, and especially transport aircraft remain important.

What of our vast armies and navies?

The A-bomb's threat to surface transport of armies implies a need for careful perfection of the art of moving armies by air. Hence, the production capacity that once was given to great fleets of bombers may now be indicated for the transport field—for carriage of supplies, of course, as well as men.

As for battleships, the argument of yore as to whether a plane could sink one already lost much of its meaning before the atomic discovery, for most of the supremacy of the battleship had been acquired by the aircraft carrier, which, then, immediately had to fight its way against opposing air power. Today, its case, or that of any other large surface vessel, is not so good in view of the contention that A-bombs can put these capital ships out of commission with mere strikes within half a mile. Another angle: While atomic bombs might have simplified our Navy's conquest of Iwo and Okinawa, atomic bombs of a defending enemy conceivably would cut short any such attempt in a future war. But a future warring nation could afford to bypass such stepping stones and strike directly at the enemy homeland.

Granted, this sort of thinking gets into the speculative sphere, but it is still a bald fact that such factors must be accounted in our new ledger of concepts. Plenty of very factual apprehensions come to mind. Conventional armies and navies are very definitely obsolescent in the light of the atomic bomb—which should lead us to inquire into all postwar military planning, as well as to use any influence we may possess to promote the atomic frame of reference.

There certainly will be some who, failing that frame, will move to maintain the outworn rather than build for the new. There will be those who will still endorse tactics and techniques of yesterday. All that can be fatal. The tenets of both war and peacetime conscription might well be switched into a new ideology of conscription of science and research brains. All this transcends the purely military. And the military itself will doubtlessly require a more smoothly working unification of air, sea, and land striking arms. Further, it must be better coordinated with our programs of foreign relations.

Finally, a more precise line of demarcation should be drawn to mesh current needs, and accordingly production, in feasible balance with the parallel capacities we expend for development of new offenses and defenses. It may be remarked that the Third Reich, in its final two years, went all out for the development of new—that is, V—weapons. Thereupon, the Allies swept

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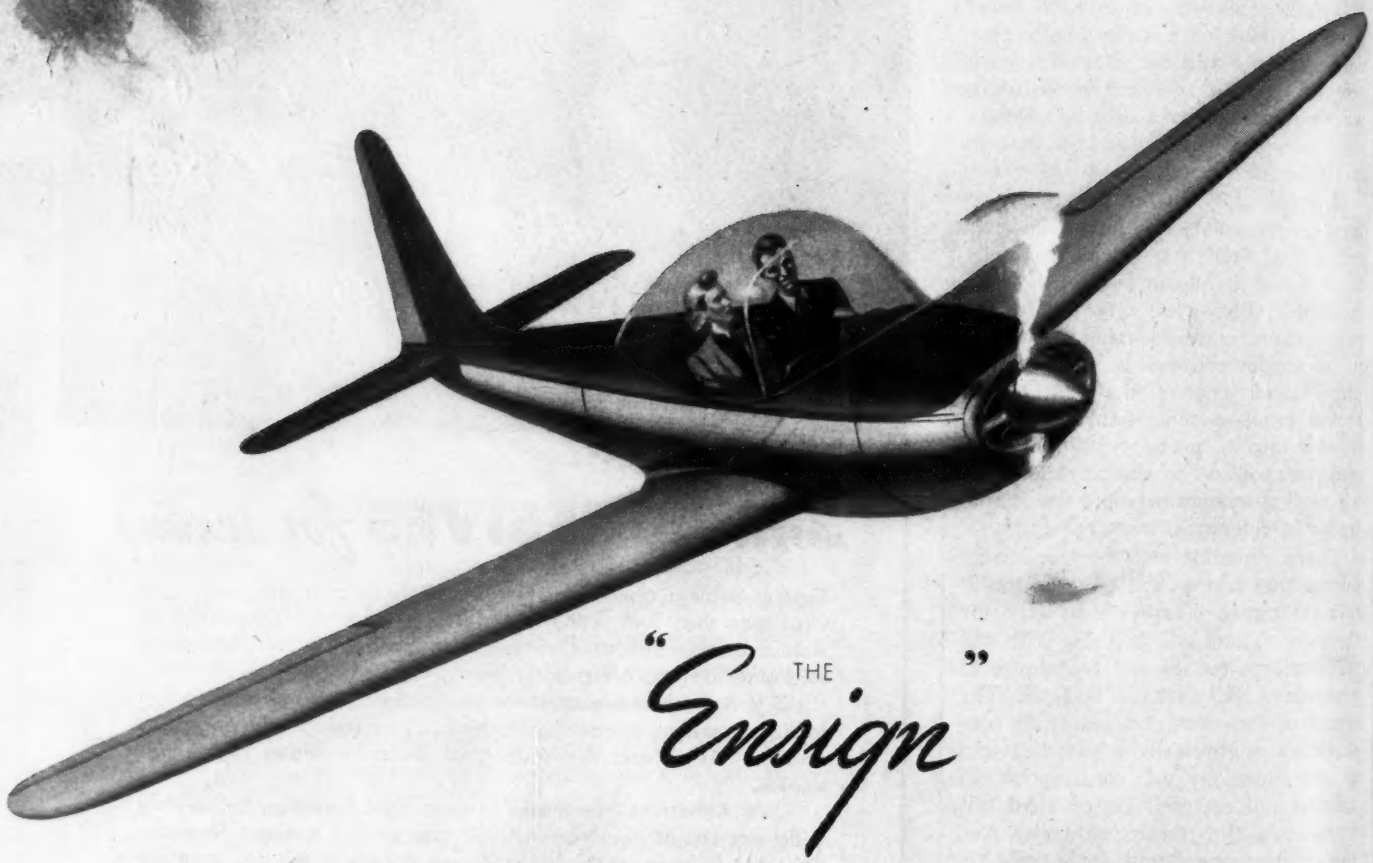

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in with fleets of "obsolescent" bombers and rang down the curtain.

With the understanding that no specific defenses, weaponwise, have been devised as yet against the atom bomb, dispersal (rather than concentration) of capital targets is indicated, though unsatisfactory. True, armies are mobile, but cities and production centers are not. A basic spread-out comes to mind. But as for taking apart his cities and stringing them out over great areas, or of moving his habitat directly underground like that of ants, the average man would tell you he'd prefer, instead, to take his chance on whatever might be tossed in his direction.

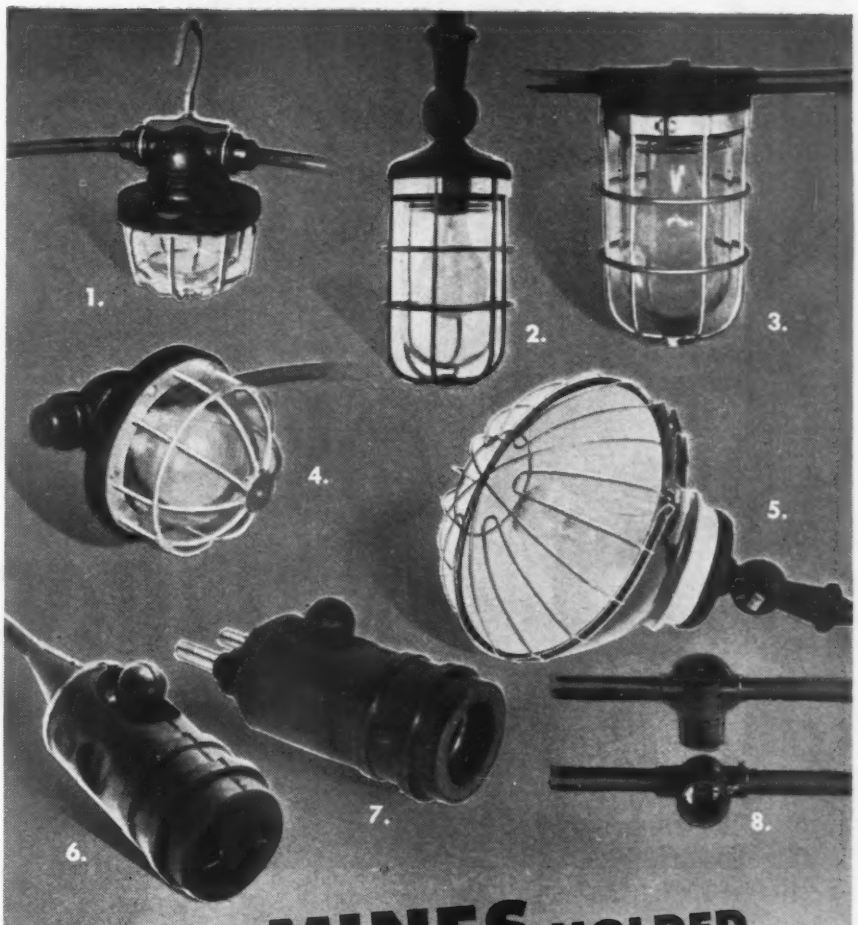
It's not yet clear, at this writing, what exact effect and range the atom bomb has on underground structures, though a geophysicist states that "even if you were underground within half-a-mile range, your chances of survival would still be zero." It's gathered that human lungs, even at a distance, couldn't "take" the pressure.

Coming back to planes carrying the bombs, fast bombers capable of operation well above effective flak range appear called for, with strong protection by fighters. Formation flying of such bombers would be "out" as unsafe and also because such tactics would no longer be required. Further, design of the atom-bomber plane will differ from that of former craft, according to weight and shape of the new missile and also in line with operational expediencies.

A word, now, on industrial angles: While the atom bomb has, variously, been called the greatest discovery since fire, since the industrial revolution, since the development of gunpowder, and if not of the ages then of our age, we may quite rightly move on from those comparisons to the one which emphasized it as "the most striking industrial achievement in history." For industry was part and parcel of the accomplishment.

Among those firms taking part were Westinghouse, duPont, General Electric, Allis-Chalmers, Chrysler, Union Carbide & Carbon, Davison Chemical Corp., M. W. Kellogg Co., Tennessee Eastman, J. A. Jones Co., Stone & Webster, and scores of others as yet unnamed. Boeing B-29's were employed to drop the bombs on Japan, and in numerous ways other aircraft were used to expedite the whole program. For one thing, air facilities were specially constructed at a point in Australia so that uranium could be flown out.

We might particularly repeat the statement by Dr. O. E. Buckley, Bell Telephone Laboratories president, con-



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cerning the discovery: "In my opinion there will be an immediate effect on industry in the impression made on industrialists of the power of scientific research, which has been appreciated by some, but not all, in industry." Our program must be constant in order that we may continue to maintain the few-years' lead we now enjoy.

Thus far, we have attempted to outline what may be considered the factors obtaining today and bearing upon the shaping of required new viewpoints. True, we have touched only upon generalities, at best, yet their implications are clear.

II. Impending Realities

At this point, we begin asking, "What next?" And under this heading of impending realities we may first arrive at futher improvements in our bomb and in projected war methods for its use. And we must perfect our concepts in tune with these developments. Meantime, it is likely that some other nation will come to solve the initial secret of the bomb, and this also will certainly demand a revised outlook.

Specifically, the device to look for next is the V-1 or V-2 type missile carrying an atom-bomb warhead and perfected by radio-electronic devices to give deadly accuracies formerly lacking in these weapons. A stream of such projectiles loosed against an enemy's homeland would add a new-conclusive element and would be more difficult to intercept than the bomber craft initially employed. With such bombs, a whole war might virtually be concluded overnight. Indeed, the near possibility of this type of missile may mean revision of our earlier-changed concepts of three military arms.

One initial defense readily conceivable at this time is the radio detection station placed hundreds of miles from our shores to flash a warning of approaching rocket or jet bombs. But the rocket weapon is already supersonic in speed, hence such a radio flash would give little time to the intended victims. Perhaps they could make their way into underground bomb shelters specially pressurized to resist the A-bomb's air pressure waves, as well as constructed, somehow, to fend off the ground blast. But the thought is not a happy one.

Regarding going underground with our war production facilities, the experience of the late war is not too encouraging on this point, either. Communications and transport to and from such sites is still highly vulnerable to opposing air power, atom or otherwise. Even if a particularly favorable underground setup could at once include

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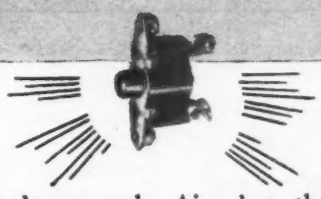

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everything from raw material to finished products, the latter would finally be a target when they had to be brought out to be put to use. The exception might be a specialized site where atom bombs were both made and then fired via rockets, but this presupposes a rather fantastic underground economy. Incidentally, the Japs were talking, just before the war ended, of how they might fit atom bombs (which they didn't have) into the noses of Kamikaze craft and then wipe out our attacking navy. But given A-bombs, the Kamikaze idea makes little sense when destruction can be planted precisely from high altitudes without need of such tactics.

Another note in the line of defense reasoning is voiced by one of our Navy spokesmen, who pictures anti-aircraft guns throwing atomic shells from our warships "to fill the skies with a concussion no present-day attacking plane could withstand." But the exact use of any warships in a war where the other side also employs the cosmic power must first be carefully calculated. And given such atom shells as those mentioned, would any warships stand a chance? That's a prime question.

Impending, too, is the proposition of a U. S.-British atomic air force for employment to keep the peace. It's now said a 2½-yr. occupation of Germany is enough, no doubt with the thought in mind that atom bombs can speedily set things right in a Germany which makes a move to re-arm.

Also under the head of the impending, is the possibility of employing deadly radio-active poisons in some particularly vicious brand of gas. Thus, lethal atomic fission is not restricted to explosive forms.

III. Theories for the Future

This entire discussion has thus far presented a 100-percent gloomy picture because the war applications, present and immediately impending, are all we have to date to go on. The first future application is seen as rocket power to send destructive projectiles to their targets across whole oceans and continents.

However, in this theoretical future there may be devised some true defenses, possibly growing out of the initial discovery. Maybe some projectiles or rays will serve to stop such weapons or carriers long before they can strike.

It is absolutely essential that research be continued to feel out such possibilities seeking to avert a dark future of cities "lying dead and unburied." Perhaps the bomb, as an achievement toward the irresistible force, can be balanced by some comparable development in the sphere of the immovable object. Let's hope that the latter wins the race.

Of course, much of the discussion following the discovery treated of the great benefits now probable for mankind, and these we all hope will be devoutly sought out. But a check of every authority puts the day of power-in-a-pill a long way off. A survey of scientists connected with the Manhattan Project indicated that the initial practical utility of the discovery for some special industrial purpose was a good 10 yr. off. This would doubtless be the use of an atom "pile" as a major utility power source. Feasibility and relative cost will continue to be commercial factors. Continuation from there to vehicle-power uses and finally to striking developments for "every-day" use which would grant the rank and file a "1-hr. work week"—is something far out in the haze.

For the powering of aircraft, some application may eventually be discovered, suitable for employment in a rocket-type craft. The idea hardly lends itself to the form of the reciprocating power plant, nor to the jet type, since the latter uses an outside air stream which is unnecessary with atomic power.

In regard to such aircraft use, the NACA terms such projections as highly speculative at this time, but it points out that with success there would be a great reduction in fuel load which would give new economies and efficiencies of flight. And super-sonic speeds would be more readily effected.

This consideration of amazing speeds brings us to the realization that high velocities over the earth must reach the point of diminishing returns. Here, we can let the astronauts take over those higher speeds which would be required for extra-global scientific flights.

It must be repeated that there is a long, discouraging row to hoe in research and experiment before atomic energy can be translated into beneficial uses. Yet, while such thoughts were only in the realm of fancy yesterday, today the release of atomic energy is a fact which must relate to some future harnessing of this power for the better life.

The world cannot forget the horrors of the atomic bomb and its threat to humanity. May the same unremitting energies of our scientists and the same generous allotment of our money as given in war be now given in peace to human benefits rather than destruction.

Review of Patents

(*Continued from page* 197)

in heat transfer rate to respective surrounding atmospheres.—2,379,293, filed Mar. 25, '42, pat. June 26, '45, De. W. R. Goddard, assignor to Radio Corp. of America.

Wing Structure allows for fabrication of constituent members in the form of subassemblies to facilitate mass production. Means are provided to separably connect shear web and forward and rear portions of wing tip and other associated parts while maintaining substantially unbroken airfoil contour to permit convenient assembly, disassembly, inspection, replacement, and adjustment.—2,379,352, filed Apr. 1, '41, pat. June 26, '45, G. W. Hardman, assignor to Edward G. Budd Mfg. Co.

Aircraft Radio Localizer System, particularly related to blind approach, continuously indicates to pilot exact relative lateral position with respect to airport in general and exact position relative to approach path to runway. Two spaced nondirectional transmitters are placed in line with desired runway, and receiver system, simultaneously tuned to both transmitters, has two needle indicators arranged to continuously and independently point out direction to each transmitter.—2,379,363, filed Nov. 27, '39, pat. June 26, '45, W. P. Lear, assignor (by mesne assignments) to Lear, Inc.

Pilot's Seat, equipped with rollers on hinged back and on rear portion of seat, operates on tracks to allow shifting from sitting position to prone position to avoid blacking out, yet permitting pilot to retain control of plane when changing from one position to other.—2,379,385, filed June 13, '44, pat. June 26, '45, P. R. Styers.

Rotary Wing Aircraft Controls, designed to permit craft to remain stationary during period of mechanical driving of rotor prior to jump, employ wheel brakes coordinated to afford automatic application when controls are adjusted to initiate rotation of rotor. Also provided is automatic release of brakes at takeoff.—2,379,847, filed Nov. 18, '41, pat. July 3, '45, R. G. Anderson, assignor to Autogiro Co. of America.

Recent Books

(*Continued from page* 197)

presents three-view aspects of design evolutions of craft (annotated with fundamental data) leading to the accepted model. Book is generously and effectively illustrated with photos and drawings.

AIRPLANE CRASH FIRE FIGHTING MANUAL. National Fire Protection Association, Boston, Mass. 96 pages, text, drawings, $1.

Presents information on best methods of meeting the fire hazard in crashed aircraft, saving lives, and minimizing property damage.

PROSPECTS AND PROBLEMS IN AVIATION. The Chicago Association of Commerce, Chicago, Ill. 212 pages, text, graphs.

Over-all discussion, of aviation prospects and problems, by twelve national authorities. Includes views on growth of the aircraft industry, expansion of airline routes, air transport, prospective passenger and cargo traffic, airport locations, design and financing, community companies, regulated competition, transport regulation, tax policies for commercial aviation, and control in relation to other transportation.

PRACTICAL MANAGEMENT RESEARCH, by Alexis R. Wiren and Carl Heyel. McGraw-Hill Book Co., Inc., New York City. 222 pages, text, index. $2.50.

An "engineering" approach to the factors making for effective control of management problems, describing methods for analyzing business operation and for conducting practical management and time studies. Examples of actual problems are given, showing by case material how they were solved.